THE
GEOLOGICAL MAGAZINE
VOLUME LX.

No. VIII.—AUGUST, 1923.

ORIGINAL ARTICLES.

The Yellow Limestone of Jamaica and its Mollusca.

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(PLATES XIV–XVIII.)

Introduction.

NEARLY a hundred years ago the limestones in the Chapelton district of Jamaica were recognized by Sir H. de la Beche as being of the age of the Calcaire Grossier or the London Clay through the finding in them of a gigantic *Cerithium* whose cast resembled that of *C. cornucopiae* Sow.[1] De la Beche does not employ the term Yellow Limestone in his table of the Jamaican rocks, but he refers to beds of yellowish limestone as forming the base of the White Limestone. The term Yellow Limestone came into use at the later period of the survey under Barrett and Sawkins.[2]

In the map of Sawkins and Brown the distribution of the various beds of yellow limestone and other formations over the whole of Jamaica was satisfactorily indicated for the first time, and the formations as they occur in the various parishes are described in the report, frequent references being made to the Yellow Limestone, the thickness of which bed Sawkins estimates at about 500 feet.

However, the unfortunate error arose of confusing together, chiefly in the eastern part of the island, some of the formations which lie above the great White Limestone, including the Bowden fossil-bearing beds, with those beneath the White Limestone, namely, the true Yellow Limestone of Eocene age, the formation described in the present paper. The latest view on the Bowden mollusca seems to be that they are to be correlated with the Middle and Upper Gatun stage of Panama and are of Upper Miocene age,[3] and that they contain about 12 per cent of recent species.

The result of this error was the publication by Sawkins and Etheridge of a list of mixed mollusca under the heading of "Miocene Fossils", which include the greater number of the Bowden fossils, together with a few recent forms collected apparently from the

[1] *Trans. Geol. Soc. London*, vol. ii, 1827, No. 36, pp. 174, pl. 21.

[2] "Reports on the Geology of Jamaica": *Mem. Geol. Surv. London*, 1869.

[3] A. A. Olsson, "Miocene of Northern Costa Rica": *Bull. of American Palæontology*, No. 39, pt. i, 1922.

raised coastal reefs together with only two species of the true Yellow Limestone, namely, *Nerita schmideliana* and *Cerithium giganteum*.

Further confusion arose in 1899 in the statement by R. T. Hill[1] that a Cretaceo-Eocene fauna occurs in beds he calls the Cambridge and Catadupa formations, which are to be seen along the railway line from Kingston to Montego Bay in cuttings between the places so called. In a map published in his report on Jamaica he gives a wide distribution to this supposed Cretaceo-Eocene formation. I have already endeavoured to show that these formations are founded on a mixed collection of Yellow Limestone and Rudist Limestone fossils and that both the beds and their fossils are in reality as distinct along this stretch of railway line as they are elsewhere in Jamaica.[2]

Sawkins appears to be in considerable doubt as regards the conformability or unconformability of the Yellow Limestone to the overlying White or Cockpit Limestone. On page 212, discussing the Yellow Limestone in the Parish of St. Elizabeth, near the west central part of Jamaica, he says that the Yellow Limestones, shales, and marls underlie the White Limestone and are evidently unconformable to it. Twelve lines further on he mentions that in the same district the limestones in the Yellow Limestone series pass up into the White Limestone. The apparent unconformity of masses of White Limestone over the Yellow Limestone in several localities in Jamaica is, so far as my observation goes, due to slipping of beds over one another, often down river valley slopes. In undisturbed sections the passage of the Yellow up into White Limestone seems to be always a gradual one.

On the map of Sawkins and Brown the Yellow Limestones are coloured green. In practically every place I examined it west of a line drawn about north and south through Kingston the green indicates the Yellow Limestone sequence of Eocene age described in this paper. In this western area the Yellow Limestone crops out round the edges of the inliers of older rocks and always follows persistently below the great White Limestone. To the eastwards of Kingston, however, matters seem somewhat different and I have never met with an exposure there that shows the fauna very plentifully or typically developed. A green patch, for instance, in Sawkins' map on the south coast up the Cane River, and east of the Cane River Falls, represents a series of beds of hard limestone at the base of the White Limestone, which are well bedded and yellowish in colour, but which failed to show any of the typical fossils of the Yellow Limestone. In certain other places the Yellow Limestone appears to be developed, though Sawkins does not indicate

[1] "The Geology and Physical Geography of Jamaica": *Bull. Mus. Comp. Zool. Harvard*, vol. xxxiv, 1899.

[2] "The Cretaceous and Tertiary Question in Jamaica": GEOL. MAG., Vol. LIX, No. 699, Sept., 1922.

it on his map. On the north side of the eastern portion of Jamaica, up the Swift River, near places marked Paradise and Elysium on Sawkins' map, a considerable thickness of Yellow Limestone occurs at the base of the White Limestone, and apparently quite conformable to it. These beds consist of yellow marly blue-hearted limestones interbedded with grey shales and conglomerates. Although the rock is full of remains in some parts, the only fossils I could identify specifically were an *Ostrea* like *O. sparnacensis* and a *Lucina* of the shape of *L. gigantea*. Both these bivalves, however, are typical Yellow Limestone forms.

R. T. Hill (p. 62) remarks that the Cambridge beds are seen in an exposure at the foot of the bluffs west of Port Antonio, and that the characteristic fauna is found in beds of pure white limestone and calcareous marl much resembling the White Limestone of the Montpellier formation. I spent some time in searching for this exposure, but without success. However, some fossil specimens in the Jamaica Institute reported to have been found at Goschen in St. Ann Parish seem to show that a fauna with *Terebellum*, *Xenophora*, *Lucina*, and other forms as casts sometimes occurs in a hard splintery bed of white limestone.

We may now refer to those portions coloured green on Sawkins' map that really represent beds above and not below the White Limestone, and therefore of post-Oligocene age. A green patch at Bowden in the south-east represents a bed of yellow calcareous marl apparently overlying the gravel and pebble deposits which contain the Bowden shell-beds. On the road near Leith Hall, a place on the west side of the bay opposite Bowden, I examined a patch of this material and found it to consist of some 20 feet of well-bedded yellow marls with layers of hard calcareous material and occasional bands and inclusions of pebbly limestone with casts of small fossils. Indeterminable fragments of some large bivalve occur which, however, do not resemble any form in the Yellow Limestone that I know. Several green patches are mapped along the extreme east coast from Port Antonio south-eastwards to the mouth of the Plantain Garden River. These all seem to indicate the beds that R. T. Hill has called the Manchioneal formation. At Amity Hall, north of the mouth of the Plantain Garden River, these beds are seen resting immediately upon the White Limestone and contain mollusca of modern aspect though apparently older than those of the raised coastal reefs. A good cutting on the road about 4 miles north of the last place shows 40 feet of light pink and yellow friable beds of limestone, much dissolved and very porous, with masses of partially dissolved coral and casts of mollusca, and an occasional *Terebratula* with the shell still preserved.

Good sections of the Manchioneal beds are to be seen at various points along this part of the coast on both sides of Manchioneal Harbour, and near the Priestman's River. It also forms the rock on which the Titchfield Hotel at Port Antonio stands, but here

the fossils are scarce and very poorly preserved. Good sections also appear on Navy Island in Port Antonio Harbour, and the stratified calcareous and marly portions of this bed which are interstratified with the coralline masses seem to be the Pteropod Marls which are described by Sawkins. R. T. Hill, however, colours the whole of Navy Island as White Limestone.

Returning to the true Yellow Limestone, after examining several of the exposures of this formation in all the districts in Central and Western Jamaica I was very soon convinced of its faunal independence and distinction, and extended collecting yielded a series of fossils that are definitely Eocene in character. My first impression of the fauna was its general similarity to that of the Sables de Cuise and the lower Calcaire Grossier, or still more to that of the "Nummulitic" beds of Monte Postale in the Veronese Alps, or to the Mokattam series of Egypt.

It seems probable that an identical fauna may be present in St. Bartholomew, a small French island in the north-east of the greater Antillean group, but further information will be required before the correlation can be established beyond doubt. P. C. Cleve[1] says the limestone of St. Bartholomew is rich in fossils generally in a bad state, and that they belong beyond doubt to the age of the Calcaire Grossier. A large *Cerithium* identical with or nearly allied to *C. giganteum*, a large *Nerita* allied to *N. conoidea* and several species of *Voluta, Rostellaria, Phorus, Cypraea, Natica*, etc., occur. He remarks that *Terebratula carneoides* Guppy is very plentiful, and that fragments of crabs of the genus *Ranina* occur.

Charles W. Cooke,[2] however, has recently described and figured some thirteen species of fossil mollusca collected by Dr. T. W. Vaughan at various places on St. Bartholomew, and none of these seems to resemble any forms I found in the Jamaican Yellow Limestone, and the describer of them refers the series to the Upper Eocene. The fossils from Antigua and Anguilla seem also unlike the Jamaican Yellow Limestone specimens.

The formation appears also to be represented in Haiti, the geological sequence of which is given by Tippenhauer and quoted by R. T. Hill (p. 172). Here the Yellow Limestone seems to be represented by yellow clay and sand, compact yellow limestone, and thin blue strata having an estimated thickness of 656 feet. This overlies a series of green, brown, and dark grey strata with fine grained sandstones which may represent the Carbonaceous Shale or Richmond beds of Jamaica. The beds above the Yellow Limestones in Haiti are said to be thin chalky strata with white marly layers often containing flints. This seems to correspond with the Montpellier beds which lie at the base of the Great White

[1] "Geology of the North-eastern West Indian Islands": Stockholm, 1871, *Kongl. Svensk. Vetensk. Akad. Handl.* bd. ix, No. 12, p. 26.

[2] "Tertiary Mollusks from the Leeward Islands and Cuba": *Publ. Carnegie Instit. Washington*, 1919, pp. 105–56, pls. 1–16.

Limestone in Jamaica. In the Republic of Santo Domingo, which comprises the eastern end of the island of Haiti or Hispaniola, matters seem to be different. Though rocks of Tertiary age are said to occupy probably two-thirds of the area of the Dominican Republic, Lower and perhaps Middle Eocene deposits were not seen.[1]

Description of Sections of Yellow Limestone in Central and Western Jamaica.

The best fossil collecting locality I met with is that near Spring Mount on the mountain slope about 7 miles south-east of Montego Bay in St. James parish where excellent sections are exposed of the Trappean beds, which are here pierced by numerous igneous dykes. The Yellow Limestone overlies these and passes gradually up into a bed which appears to be typical White Limestone. The junction of the Trappean shales and the Yellow Limestone is seen some distance down the road below Spring Mount Court House, and appears to be an unconformable one. Several "rarities" among the fossils occur at Spring Mount, and the section may be taken as a typical one of the Yellow Limestone, though neither the faunal nor the lithological succession seems to be very constant over any wide area in Jamaica.

The Yellow Limestone Section at Spring Mount.

The total thickness is about 470 feet, though it is possible that some of the beds may be repeated by faulting in this section.

	Thickness in feet.
Hard white or Cockpit limestone	?
Hard and massive pink and brown limestone full of sections of fossils, including mollusc and echinoderm fragments	30
Brecciated and porous limestone, no fossils seen	15
Marly, yellow soft limestone, with *Ostrea*, *Velates*, etc.	20
Brown nodular limestone, with *Cerithium giganteum*	30
Black sandy lignitic shale, with *Ostrea*	6
Yellow nodular argillaceous limestone, with large *Carolia* and other fossils	30
Brown shaly and sandy limestone full of *Ostrea multicostata*, *Lucina gigantea*, *Cerithium giganteum*, *Terebellum*, and many other forms	20
Pebbly sandstone	15
Brown shaly limestone	20
Yellow and brown friable limestone full of *Ostrea multicostata* and *Cerithium giganteum*	40
Yellow argillaceous limestone with *Carolia*, *Ampullina*, etc.	30
Grey shale, no fossils seen	15
Yellow limestone with *Velates*	10
Grey shale	20
Hard yellow limestone	6
Yellow argillaceous nodular limestone, numerous fossils, *Velates*, *Cerithium*, *Ampullina*, *Terebellum*, *Carolia* (very scarce), crab claws, corals, echinoderms	40
Hard yellow limestone, the masses with blue interiors.	20
Hard pink and white limestone with *Lucina*, etc.	30

[1] Geol. Survey of the Dominican Republic: T. W. Vaughan and others. Prepared by the U.S. Geol. Survey, 1921, Memoir, vol. i, p. 56.

	Thickness in feet.
Grey and red shale, no fossils seen	20
Yellow limestone with a few bivalves	30
Porous and brecciated limestone, no fossils seen	20
Red Trappean shales with igneous intrusions	?

In the valley of the Tangle River in St. James' Parish about 5 miles south-east of the last described exposure, and forming a continuation of it, about 100 feet of argillaceous Yellow Limestone are seen, in which fossils are numerous, *Terebellum* and *Cerithium giganteum* especially so. A portion of a road is almost paved with gigantic *Cerithia*. As at Spring Mount, the Yellow Limestone rests on the Trappean shales and conglomerates, the Carbonaceous Shale or Richmond beds being absent. Several sections in this area show the gradual upward passage of the Yellow into the great White or Cockpit Limestone, the passage consisting of a series of pink or brown compact beds in which only sections of small fossils are seen.

Along the railway line between points 1 and 3 miles south of Cambridge, the Yellow Limestone follows closely upon the Rudist Limestones, with only a bed of red shale intervening, the Richmond beds being again absent. I have already published a section showing the order of the beds here.[1] The Yellow Limestone sequence consist of :—

	Feet (approximate).
Laminated fissile yellow marly limestone, with *Carolia* and small oysters, chiefly *Ostrea multicostata*	16
Fine-grained yellow limestone, full of small foraminifera and other microscopic organisms	6
Yellow limestone, full of small oysters and large Ampullina-like and other gasteropods ; large Lucinæ near the base Light yellow marly limestone weathering into large and small nodular fragments with casts of large and small Ampullina ; Maussenetia and other gasteropods ; Lucina, etc.	20
Brown and red leafy shale, fossils very scarce and indeterminable	20
Rudist Limestones	30

The relation of the Yellow Limestone to the Cretaceous beds can be well studied along the railway line, but the overlying masses of White Limestone are in most cases displaced and have to some extent slipped down the slope of the valley of the Great River.

About 3 miles from Cambridge on the road to Montego Bay the Yellow Limestone beds dipping at fairly high angles are seen in the bed of a stream crossed by two or three small bridges, and consist of :

	Feet.
Carbonaceous nodular sandy shales, with *Carolia*, *Ampullina*, *Rimella*, and other gasteropods, and flattened carbonaceous fragments	15 ?
Beds of flattened *Carolia* and *Ostrea*	10
Blue, grey, and yellowish sandy limestone and calcareous nodular shales, with casts of gigantic *Cerithia* and smaller gasteropods and bivalves	16–20

Neither the base nor the top is seen in this section.

[1] Geol. Mag., Vol. LIX, 1922, p. 422.

Round the edges of the large mass of Trappean shales and Cretaceous limestones that occupy the watershed of the Rio Minho in the centre of Jamaica, the Yellow Limestone is widely exposed and must have a thickness of about 500 feet. It is well seen at Ulster Spring; Christianna; above Logie Green; at Chapelton, and numerous other places. Several of the beds consist of massive blue-hearted yellow marly limestones, in which large oysters, apparently of the genus *Crassostrea* often occur massed together. A similar series of fossils to that at Spring Mount appears to be present, but they are generally less satisfactorily preserved.

Some distance down the road from Spaldings towards Logie Green, a bed of yellow calcareous marl containing large flat foraminifera the size of a penny is noticeable, but the sequence of the beds is not clear in this section. I have not noticed these large foraminifera elsewhere in Western Jamaica in the Yellow Limestones.

The Carbonaceous Shale or Richmond beds are wanting in this area, but around and near Christianna the base of the Yellow Limestone seems to consist of a series of yellow marly sandstones which may be the local equivalent of the Richmond beds. These basal beds appear to have resulted from washing up of the underlying Trappean shales and sandstones. Sawkins (p. 169) remarks that the junction of these marls with the underlying beds is difficult to trace.

Near Glasgow, on the borders of Westmoreland and Hanover parishes in the far west of the island, good sections of the Yellow Limestone are seen passing conformably up into hard white limestone of the normal Cockpit type. The sequence here consists of:—

	Feet.
Massive blue and yellow compact limestone, with sections of echinoderms, oysters, and a few casts of bivalves resembling *Corbis*	40
Yellow nodular argillaceous limestone, with gigantic *Cerithia* and *Lucina*, *Velates*, numerous echini, crab-claws. The fossils are mostly poorly preserved, the rock becoming very marly near the base	40

Between Glasgow and Lucea Harbour, about 8 miles to the north-east, an extensive development of the carbonaceous shale or Richmond beds occurs and the Yellow Limestone may rest conformably on the shales of the Richmond beds in this area, but owing to soilwash and tropical vegetation the actual junction of the two beds is very difficult to observe.

Palæontology.

J. G. Sawkins gives a brief general description of the Yellow Limestone, in which he remarks that the formation, though essentially marine in character, seems to have been terminated by estuarine deposits since the uppermost beds consist of carbonaceous shales containing brackish water shells. Although beds of lignite and

dark carbonaceous shales occur here and there in the sequence, I failed to find any of the freshwater shells. I imagine, however, that some casts of *Ampullina* having a general resemblance to forms of *Limnaea* or *Paludomus* may have given rise to this supposition. Sawkins mentions two species only from the Yellow Limestone, namely, *Nerita schmideliana* and *Cerithium giganteum*, but the occurrence of large and thick-shelled oysters is referred to in his text.

The mammal *Prorastomus sirenoides* Owen,[1] whose skull is now exhibited in the British Museum (Natural History), is recorded from Freeman's Hall estate in the south-east corner of Trelawny Parish, and is almost certainly from the Yellow Limestone. Sawkins refers to it on page 218. R. T. Hill gives a list of mollusca, determined by T. W. Stanton, which he collected in beds exposed along the railway line between Cambridge and Catadupa; these are mostly generic names and include both Eocene and Cretaceous forms. The corals that he collected were described by T. W. Vaughan in an appendix to Hill's work, but Cretaceous and Eocene forms are again mixed together in the description and plates. This is the fault, however, of the collector and not of the describer of them.

The corals I collected in Jamaica have been sent to Dr. T. W. Vaughan, and so I have no doubt matters will be put right in this respect. The Crustacea are being dealt with by Mr. T. H. Withers, F.G.S., and the Echinoderms are in charge of Professor H. L. Hawkins, D.Sc. I found neither Cephalopods nor Brachiopods in the Yellow Limestone.

The present is only a preliminary description of the mollusca of the Yellow Limestone. Some day perhaps, after more collecting, the fauna of the Eocene of Jamaica may be monographed, when it will probably prove to be as rich and varied as that of any area of a similar period elsewhere. I think it advisable to publish these results, however, to enable workers to have some idea of the nature of the Yellow Limestone mollusca, because it has recently been stated that the Cambridge and Richmond formations of Jamaica are of Upper Eocene age,[2] that is, of Ludian and Bartonian age. There can be no doubt after examining the mollusca I collected in Jamaica that the Yellow Limestone is approximately Lutetian, that is to say, of Middle Eocene age. It shows strong affinity with the upper part of the Ranikot and with the Laki and Kirthar series of India; the upper part of the Libyan and the Mokattam series of Egypt; the Eocene fauna of Senegal described by Douvillé; the Monte Postale beds of the Veronese Alps; and the Sables de Cuise, and the lower and perhaps all of the Calcaire Grossier of the Paris Basin. The affinity of the fossils with those of the Martinez

[1] *Q.J.G.S.*, vol. xi, 1855, pp. 541–3.

[2] T. W. Vaughan, "Geol. History of Central America and the West Indies during Cenozoic time": *Bull. Geol. Soc. America*, vol. xxix, 1918, p. 623.

or Tejon Eocene of California seems to be very slight. The scanty fauna of the Carbonaceous Shale or Richmond beds which underlie the Yellow Limestone suggests a Cuisian or Sparnacian horizon, and there seem to be only one or two forms that pass up into the Yellow Limestone.

The statement that in the Cretaceous and early Tertiary in Jamaica one collects fossils of European rather than American aspect is rather a platitudinous one and requires some qualification. The Cretaceous fossiliferous shales and Rudist limestones bear a general lithological resemblance to those, for instance, of the Gosau district of Austria, a fact which impressed the early observers, yet the Rudist facies of the Cretaceous is not confined to the Antillean Islands, but is widespread on the mainland of North and Central America.

A certain fauna which I have traced at two widely separated localities in Jamaica appears to be the oldest in the Island. It occurs in shales between Catadupa and Cambridge, and again at Providence near Port Antonio, and in both places underlies some and possibly all of the Rudist limestones. The fossils are apparently of Upper Senonian (Campanian) age, and include a *Roudairia* very like the Egyptian *R. drui*; *Pecten quinquecostatus*; *Baculites*; and, rather low in the sequence at Providence, some Ammonites, one of which Dr. L. F. Spath informs me belongs to the genus *Parapachydiscus*. The relationships of this fauna are to some extent Old World, but some of the forms seem to have Mexican affinities.

The Rudist limestones of Jamaica, with their gigantic and gigantesque Rudistæ, should, I think, be attributed to the Maestrichtian. The Rudistæ, and probably the gasteropods also, however, are far removed from European species. *Barrettia* and possibly all the Rudists are peculiar to Central America and the Antilles. *Caprinula gigantea* Whitf., which seems to be a gigantic form of *Ichthyosarcolites*, occurs in nearly every section I examined in Jamaica. *Radiolites* (*Lapeirousia*) *nicholasi* Whitf. is probably the largest crateriform Radiolite known. I recently collected a small species of Hippurites high up in the Logie Green section associated with the peculiar crab *Carcinoretes woolacotti*, Withers gen. et spec.[1] The Hippurite seems very like a small form known from Mexico. *Barrettia sparcilirata* Whitf. occurs much lower down in the Logie Green section associated with *Radiolites nicholasi*. The occurrence of a *Cardita* related to the Indian Maestrichtian form *C. subcomplanata* seems to support the late Cretaceous date of the Barrettia bed. This, however, has been questioned by Prof. H. L. Hawkins[2] after his examination of an echinoderm,

[1] *Ann. and Mag. of Nat. History*, ser. ix, vol. x, 1922, p. 534, pl. xvi, xvii. The type specimens were collected by Dr. D. Woolacott at Trout Hall, 5 miles east of Logie Green.

[2] "Some Cretaceous Echinoidea from Jamaica": GEOL. MAG., Vol. LX, 1923, pp. 199–216.

Metholectypus trechmanni, which I collected in the Barrettia bed. He refers this and other echinoderms to the Upper Cretaceous, but not above the base of the Senonian. I prefer, however, to date beds by an assemblage of mollusca rather than by single species of other forms. The Eocene fauna of the Carbonaceous Shale or Richmond beds is too scanty to allow of much correlation, and many of the gasteropods are freshwater forms. It is certainly in the Yellow Limestone that one finds the closest approach as regards number of identical or closely allied mollusca to the Old World forms. The nearest geographical point in the Old World to Jamaica is Senegal, and it is significant to find there a very similar fauna of Lower and Middle Eocene age, recently described by Douvillé.[1]

Above the Yellow Limestone, the mollusca of the great White Limestone (Upper Eocene and Oligocene ?) are so miserably preserved that I have not been able to make much of them, but they do not seem to bear much resemblance to European forms. As might be expected, there do not seem to be any species common to the Yellow Limestone and Bowden beds.

The following list of mollusca is the result of my two "winter" seasons collecting in the Yellow Limestone in Jamaica. All were collected by myself or by friends under my supervision. There are several forms in addition to these, but too poorly preserved to be specifically determinable.

GASTEROPODA.

Velates schmideliana Chem. and varieties (genus "*Provelates*" of Noetling).
Terebellum subdistortum sp. nov.
Ampullospira, cf. *Levesquei* d'Orb.
,, cf. *Oweni* d'Archiac.
Ampullina, cf. *sphaerica* Desh.
Ampullina sp. (like *A. sigaretina* Lam.).
Ampullina limnæoides sp. nov.
Natica (*Naticina*), cf. *ampulliniformis* Coss and Piss.
Ampullina (*Crommium* ?) sp.
,, cf. *depressa* Lam.
,, or *Natica* spp.
Cypræa (*Cyprædia*) *subelegans* sp. nov.
,, ,, cf. *elegans* Defr.
Xenophora sp. (cf. *Trochus cumulans* Brongn.).
Campanile, cf. *giganteum* Lam.
,, cf. *cornucopiæ* Sow.
,, cf. *incomptum* Dixon.
Cerithium (species indeterminable).
Clavilithes jamaicensis sp. nov.
Maussenetia Cossmanni sp. nov.
Turbinella (*Eovasum*) sp. (cf. *T. frequens* Mayer-Eymar).
Volutilites ? (an indeterminable cast).
Gisortia, cf. *Murchisoni* d'Archiac.
,, sp. (cf. *G. postalensis* Oppenheim).
Dolium jamaicense sp. nov.

[1] "l'Éocène au Soudan et au Senegal": *Bull. du Comité d'Études Scientifiques de l'Afrique Occidentale Francaise*, 1920, pp. 113–70, pls. 1–5.

Heligmotoma sp. (cf. *H. libycum* Oppenheim).
Rostellaria (?) sp.
Rimella, cf. *Prestwichi* d'Archiac.
„ sp. (cf. *R. libyca* Oppenheim).
„ sp. (cf. *R. fissurella* Linn.).
Trochus (*Monodonta*), cf. *Zignoi* Bayan.
Conus sp. (cf. *C. brevis* Sow.).
Turritella sp. (shape of *T. hybrida* Desh.).
Hipponyx sp.

LAMELLIBRANCHIATA.

Pseudoheligmus (?) *jamaicensis* sp. nov.
Carolia, cf. *placunoides* Cantraine.
„ *jamaicensis* Dall.
Lucina (*Pseudomiltha*), cf. *gigantea* Desh.
„ „ sp. (cf. *L. mutabilis* Lam).
„ „ sp. (cf. *L. pseudogigantea* Oppenheim).
Lucina sp.
Crassostrea, cf. *soudanensis* Douvillé.
Ostrea (*Pycnodonta*) sp.
„ sp. (cf. *O. cariosa* Lam.).
„ *multicostata* Desh.
„ cf. *cubitus* Lam.
„ cf. *plicata* Sol.
„ cf. *sparnacensis* Defr.
Spondylus sp.
Modiola sp.
Cardium (*Trachycardium*) sp. (shape of *C. subfragile* d'Orb.).
„ „ sp. (shape of *C gratum* Defr.).
„ (*Loxocardium* ?) sp. (shape of *C. obliquum* Lam.).
Cardium sp. (large species in the form of casts).
Corbis jamaicensis sp. nov.
Barbatia sp.
Tellina (*Macaliopsis*), cf. *reticulata* Bellardi.
Cytherea (*Meretrix*) sp.
Venus sp. (cf. *V. blandiana* Guppy).

NOTES ON THE MOLLUSCA OF THE YELLOW LIMESTONE.

Velates schmideliana Chemn. (Pl. XV, Figs. 1, 2, 3.)

Description.—The Jamaican shells of this species, of which I collected about fifty examples, nearly all from Spring Mount, show great range of variation in marginal outline, height, and position of spire, and especially in the size and depth of the furrow which in some specimens is found on the right side in front of the apex and is continued to the margin. Some lack any trace of this fold and exhibit a smooth and regularly rounded and evenly grown shell surface, in others it is merely a shallow collapsed sulcus, while in extreme cases (Fig. 3) it amounts to a deep infolded plication. Examples of the first and last seem at first sight like distinct species or even genera, but the presence in Jamaica of all intermediate stages shows that the feature is merely a varietal one. Curiously enough, it seems to be largely an accidental one. The shell commences growth like that of an ordinary Nerita, but when a certain size is reached which seems to vary in different individuals, the interior structure is partly resorbed and growth is resumed completely round the margins and on the under side as a basal callus

till the large size of the adult shell is attained. The resorption of the columella and spire seems in some individuals to proceed too far, resulting in a collapse of the surface of the shell in the region of the suture line often with partial or complete obliteration of the spire. The groove formed by this collapse is continued throughout, the further growth of the shell resulting in a greater or less development of the furrow.

F. Noetling[1] describes the deeply furrowed type from India and Burma as a new genus *Provelates*, and gives a diagnosis in which he says that the spire is invisible and the inner lip probably not denticulated. One of his figures is exactly like the extreme forms from Jamaica, but in some of the Jamaican specimens the inner lip is certainly toothed. Noetling says that so far as he knows his genus *Provelates* is restricted to the Kirthar group. This lies above the Ranikot beds.

Dimensions.—The smallest example is about 3 mm. in diameter. The largest is 127 mm. long, 95 mm. broad, and 75 mm. high. Its apex is of the normal Nerita type and it has no furrow. Very large examples seem to have the apex filled up with calcite, as in the spiral portion of the recent shell *Magilus*.

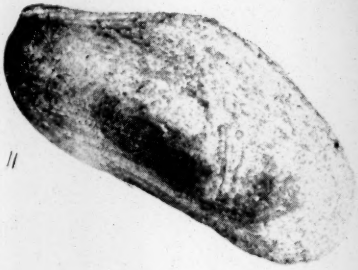
Locality.—Spring Mount where it is common almost throughout the lower four-fifths of the section, and in the upper half is accompanied by *Carolia*; railway cutting south of Cambridge, where it is rare in beds underneath the *Carolia* marls; Glasgow rather scarce.

Remarks.—I was not aware that Sawkins had mentioned this shell from Jamaica when I was pleasurably surprised to find it at Spring Mount. It is one of the most widely distributed fossils known. In the Paris Basin it characterizes the Sables de Cuise and seems to pass up into the base of the Calcaire Grossier. Specimens from Cuise appear to belong all to the smooth type without any fold. It marks the Lutetian horizon at Kressenberg in Bavaria and at Monte Postale in the Veronese Alps, and at Ronca beds with it are referred by E. Haug to the Auversian, but he remarks that some authors refer them to the Lutetian. It occurs also in Istria, Dalmatia and the Bakony Forest in Central Hungary, and in Transylvania. In Egypt it occurs in the Lower Mokattam series, and marks the Lutetian, whereas the higher part is characterized by *Carolia* and referred by Haug to the Auversian, a sequence apparently paralleled in Jamaica. Douvillé records it from the Soudan, and in south Madagascar it is recorded with *Terebellum obtusum*, probably from Lutetian beds.

C. W. Cooke[2] figures two specimens of a fossil from St.

[1] "Velates in India and Burma": *Rec. Geol. Surv. Ind.*, xxvii, pp. 103-7, pls. i–ii, 1894.

[2] T. W. Vaughan and others, "Contributions to the Geol. and Pal. of the West Indies": *Publ. Carnegie Institut, Washington*, 1919, p. 126, pl. v, figs. 7, 8.



C. T. T. photo.

To face p. 348.]

YELLOW LIMESTONE MOLLUSCA, JAMAICA.

DUP

Bartholomew in the Leeward Islands, which may be related to or derivatives of this shell. He names them *Neretina* (?) *grandis*.

A single broken specimen I found in the conglomerates of the Carbonaceous Shale at Port Maria in Jamaica belongs to another species of Velates. I regard the varied forms in the Yellow Limestone as a late development of the species probably passing well up into Lutetian times.

Terebellum subdistortum sp. nov. (Pl. XVIII, Figs. 8 and 9.)

Description.—Shell thin, slender, elongated, the spire protracted and emergent; consisting of seven whorls, the first four very small, the last three increasing rapidly in height. The body whorl comprises about four-fifths of the total height. The suture is shallow or superficial and passes irregularly across the shell; on the body whorl it is very oblique, passing diagonally forwards and then backwards again, the lip being reflected towards the spire. Aperture narrow, widening anteriorly. The outer lip is widened anteriorly and has an upward curve.

Dimensions.—Length 85 mm., width 20 mm.

Locality.—Spring Mount, rather plentiful. Tangle River valley, plentiful.

Remarks.—This large Jamaican *Terebellum* has a much more emergent spire than any of the Paris Eocene forms, except perhaps than *T. fusiforme* Lam. It seems to be closely related to an Indian species, *T. distortum* d'Archiac and Haime,[1] which occurs in the upper Ranikot beds, but is considerably larger.

Ampullospira, cf. *Levesquei* d'Orb. (Pl. XVI, Figs. 22 and 23.)

Description.—Shell consists of seven or eight whorls, which are smooth and well rounded, the suture fairly sunken, the spire acuminate. Aperture oval, umbilicus and columellar callosity slight.

Dimensions.—Length 34 mm., diameter 23 mm.

Locality.—Spring Mount; sandy beds on railway line 2 miles south of Cambridge with *Ostrea multicostata*, and elsewhere.

Remarks.—These shells belong to the group of *A. acuminata* Lam.; *A. producta* Desh.; and *A. scalariformis* Desh. of the Cuisian and Lutetian of the Paris Basin. Some specimens closely resemble *A. Levesquei*, as illustrated by Cossmann and Pissarro in *Iconographie*, tome ii, pl. xi. The suture is much less sunken than it is in *A. acuminata*. The spire is more produced than it is in *Ampullospira* (?) *adela* Cossmann and Pissarro, from the Ranikot beds. It agrees in size and elevation of spire with *Amauropsis alveata* Conrad, from the Tejon of California, of which R. Arnold gives a

[1] *Nummulitique de l'Inde*, 1853, p. 334, pl. xxxii, figs. 19 and 19*a*. Also Cossman and Pissarro, "Mollusca of Ranikot Series," *Pal. Ind.*, vol. iii, mem. i, 1909, p. 49, pl. v, figs. 6, 7, 11.

good illustration,[1] but in the Tejon species the whorls seem to be flattened below the suture, which is not the case on the Jamaican shell.

R. J. L. Guppy refers to this figure[2] and remarks that he thinks the Tejon species is the same as *Natica phasianelloides* d'Orb. Apparently d'Orbigny gave a figure only of his Cuban shell, but Guppy quotes the species as a Miocene form in Jamaica, Haiti, and Anguilla[3] and redefines it as follows: "Shell, ovate, globose, smooth, scarcely rimate, spire elevated, columellar callus narrow, its margin rimate on the penultimate whorl."

I have no doubt that Guppy's specimen came from the Yellow Limestone in Jamaica, which was not then clearly defined from the Bowden beds which were referred to the Miocene.

Ampullospira, cf. *Oweni* d'Archiac and Haime. (Pl. XVI, Figs. 15 and 16.)

Description.—Shell of eight whorls, smooth and gently rounded, increasing gradually in size; spire very elevated, pointed, suture fairly sunken.

Dimensions.—Original length 57 mm., diameter 26 mm.

Locality.—Spring Mount.

Remarks.—These specimens which are mostly casts, bear a close resemblance to examples of *Ampullospira* (?) *oweni* from the uppermost Ranikot beds, as figured by Cossmann and Pissarro.[4]

Ampullina, cf. *sphaerica* Desh. (Pl. XVI, Fig. 21.)

Description.—Shell thick, of about five whorls, spherical, spire low, growth lines fine.

Dimensions.—Height 24 mm., diameter 23 mm.

Locality.—Railway line 1 mile south of Cambridge, in hard limestone.

Remarks.—This specimen has the aperture hidden in rock, but the rest of it agrees with specimens of *A. sphaerica* I once collected at Liancourt in the lower Calcaire Grossier. It agrees with this species, and also resembles *A.* (*Crommium*) *mercinensis* Desh. as figured in the *Iconographie* (tome ii, pl. xi, figs. 64–20). Both these are Lutetian species, and the Jamaican shell possibly resembles more closely the latter one, which has a rather more elevated spire than *A. sphaerica*.

Ampullina sp. (Pl. XVI, Fig. 20.)

Description.—Shell of four or five whorls, the last very large and inflated. Spire small, suture slightly sunken, inner lip not callous.

[1] "Palæontology of the Coalinga District," *U.S. Geol. Survey Bull.* 396, 1909, pl. iv, fig. 21.

[2] "Geol. of Antigua and other West Indian Islands," *Q.J.G.S.*, vol. lxvii, No. 268, 1911, p. 685.

[3] "West Indian Tertiary Fossils," GEOL. MAG., Dec. II, Vol. I, 1874, p. 13.

[4] *Pal. Ind.*, vol. iii, No. 1, 1909, pl. vi, figs. 22 and 23.

Dimensions.—Height 22 mm., diameter 27 mm.

Locality.—Spring Mount.

Remarks.—This shell has the general shape and wide aperture of *A. sigaretina* Lam. of the Calcaire Grossier, but is smaller and has a lower spire. It may perhaps be compared with *A. mutabilis*; Solander from the Bartonian of Le Ruel as figured in *Iconographie* (tome ii, pl. xi, figs. 64–25).

Ampullina limnæoides sp. nov. (Pl. XVI, Figs 17 and 18.)

Description.—Shell of about six whorls, which increase rapidly, very thin, surface well rounded. The last whorl is large and expanded; in some specimens it is rather lengthened, in others more expanded transversely. The apex is pointed, the suture well impressed and rather sunken, the whorl flattened or slightly excavated immediately below the suture. Umbilicus is narrow, shallow and sinuous, and there is a slight lengthened sinuous columellar callus. Growth lines are fine and close set, and become slightly foliaceous towards the aperture.

Dimensions.—Fig. 17 is 30 mm. high and 24 mm. wide; Fig. 18 is 24 mm. high and 25 mm. wide.

Locality.—Grey sandy beds in the Yellow Limestone in the bed of a stream 3 miles north of Cambridge on the road to Montego Bay with *Carolia*, and rather above the beds with gigantic *Cerithia*.

Remarks.—This is a very thin shelled *Ampullina*, some of the casts suggest in shape the recent freshwater shell *Limnæa peregra*. It belongs apparently to the group of *Ampullina sigaretina* Lam. of the Paris Lutetian. I have compared the Jamaican shell with several examples of that species I once collected at Grignon. The shape is rather similar and there is the same tendency to foliation of growth lines near the margin, but the whorls increase more gradually in the Jamaican species.

Natica (*Naticina*), cf. *ampulliniformis* Cossm. and Pissarro. (Pl. XVI, Fig. 24.)

Description.—Shell almost globular, of about five whorls, the spire low and blunt. The suture is fairly deep, the umbilicus rather wide and deep and not callous.

Dimensions.—Height 16 mm., diameter 15 mm.

Locality.—Spring Mount, generally as casts.

Remarks.—These specimens seem to resemble in general shape the above species from the lower beds of the Upper Ranikot, but though mouth features, etc., seem similar no very close comparison is possible.

Ampullina (*Crommium* ?) sp. (Pl. XVI, Fig. 19.)

Description.—Shell thin, consisting of five whorls, globose, spire low, sutures deeply channelled. Body whorl large, spheroidal with a fairly wide and deep umbilicus. Growth lines fine, scarcely perceptible towards the margin.

Dimensions.—Height 20 mm., diameter 22 mm.

Locality.—Railway line 1 mile south of Cambridge, and other localities.

Remarks.—The suture is as deep or deeper than in the Bartonian *N.* (*Naticina*) *ambulacrum* Sow., but the spire is much lower and the umbilicus wider. The spire is also lower than it is in the Ranikot species, *A.* (*Crommium*) *pervicina* Cossm. and Pissarro.[1]

Ampullina, cf. *depressa* Lam. (Pl. XVII, Fig. 3.)

Description.—Shell consisting of five or six whorls, thick, smooth, inflated, the spire is blunt, about a third the height of the body whorl, suture shallow, inner lip with an umbilicus partly covered by a thin callosity.

Dimensions.—Height 50 mm., diameter 52 mm.

Locality.—Spring Mount, one specimen, the surface much bored.

Remarks.—This specimen closely resembles an *Ampullina*, apparently of the above species, that I have from Ronca in the Veronese Alps, but in that one the growth lines are more marked. It appears similar to the Parisian species from the Calcaire Grossier, but has the body whorl less flattened beneath the suture.

Cypræa (*Cyprædia*) *subelegans* sp. nov. (Pl. XV, Fig. 4.)

Description.—Shell thin, ovoid, spire nearly or entirely concealed, anterior channel very slightly produced, posterior channel with a somewhat produced rounded outer lip. The outer lip is incurved and denticulated. The whole surface is decorated with sharp parallel ridges, which are very even and almost equidistant from one another and continue across the back and outer and inner lips and are about 29 in number. There are also faint vertical ridges which tend to form a reticulate ornamentation.

Dimensions.—Length 32 mm., diameter 23 mm.

Locality.—Spring Mount, one specimen, rather low down in the sequence.

Remarks.—This shell belongs to the group of *C. elegans* Defr. and *C. sulcosa* Lam. of the Lutetian, but is larger than either of these. It is more regularly oval than *C. elegans* and has the anterior outer lip more produced.

Cypræa (*Cyprædia*), cf. *elegans* Defr. (Pl. XV, Figs. 5 and 6.)

Description.—Shell ovoid, inflated, spire concealed, anterior channel rather produced, posterior end of outer lip rounded. Surface covered with reticulate ornamentation, but this is almost obliterated in some specimens.

Dimensions.—Length 21 mm., diameter 15 mm.

Locality.—Spring Mount, 5 specimens.

Remarks.—This form agrees in shape and ornamentation, so far as this is preserved, with the Paris Lutetian shell, but is about a

[1] *Pal. Ind.*, vol. iii, No. 1, 1909, p. 71, pl. vii, figs. 9–12.

C. T. T. photo.

YELLOW LIMESTONE MOLLUSCA, JAMAICA.

To face p. 352.]

DUP

third larger. Mr. L. V. Dalton records this species from Burma,[1] and it occurs also in the nummulitic beds near Nice (Chateau Palarea), Monte Postale, Ronca, Egypt, etc.

Xenophora sp. (Pl. XVI, Figs. 7, 8, and 9.)

Description.—Shell of four to five whorls, the spire broad conical and fairly high, whorls increasing slowly in size, suture well impressed, upper surface of the whorls undulating, showing that the attached bodies were irregular in size and shape. Some of these, which seem to consist of irregular sized pieces of shell and coral, had an area of attachment extending from the suture to, and in some cases beyond, the margin of the whorls. The margin fairly acute and the underside concave with a fairly wide and deep umbilicus.

Dimensions.—The largest example is 40 mm. in diameter and about 23 mm. high.

Locality.—Spring Mount, common; Glasgow, etc.

Remarks.—This form resembles in some ways specimens of *X. agglutinans* Lam., of which I once collected several examples at Grignon, which have a similar concave underside and deep umbilicus, but the Parisian shell is a more delicate one with whorls increasing more slowly in size. It more closely resembles some specimens with the same name from the London Clay in the British Museum. *X. cumulans* Brongniart from the Bartonian, as illustrated in the *Iconographie*, has no apparent umbilicus.

In the indentation of the surface where the objects were attached and in the basal concavity the Jamaican specimens closely resemble a cast figured as *Trochus cumulans* Brongniart by d'Archiac and Haime (*Nummulitique de l'Inde*, p. 291, pl. xxvi, fig. 16) from the marls with *Nummulites garansensis* of the Chaine d'Hala, but the Jamaican form seems to have the base less hollowed.

Campanile, cf. *giganteum* Lam. (Pl. XVII, Fig. 1.)

Description.—Owing to the poor state of preservation of the gigantic *Cerithia* in Jamaica it is difficult to make a definite specific determination as this must be founded largely on the shape of the lip or the curve of the growth lines on the body whorl. Most examples occur not exactly as casts but with the shell crushed or partly destroyed. Judging by the rate of increase of the whorls and the arrangement of the nodes nearly all the specimens I collected seem referable to *C. giganteum*.

Dimensions.—The figured example must have been about 13 inches long when complete.

Locality.—They are very plentiful at Spring Mount, where a wall on the roadside is largely made of them; in the Tangle River valley, where they attain fully the size of the Paris Basin examples; Glasgow, etc.

[1] *Q.J.G.S.*, vol. lxiv, No. 256, 1908, p. 629, pl. lvii, figs. 7 and 8.

Remarks.—It is probable that more than one species of *Campanile* occurs in Jamaica since, as has already been mentioned, De la Beche figures a cast from Chapelton, which consists of five whorls decreasing gradually in size. The spire is missing and there are no prominent nodes, and he mentions that it resembles *C. cornucopiæ* Sow., but being only a cast he found it difficult to refer to any particular species but thinks it may be a new one. I have a fragment of four whorls from Spring Mount which seems to be referable to *C. incomptum* Dixon, a species that occurs at Damery.

Mr. R. B. Newton [1] figures casts of varieties of *C. giganteum* from Somaliland.

Clavilithes jamaicensis sp. nov. (Pl. XV, Fig. 9.)

Description.—Shell of eight or nine whorls, the first five are longitudinally ribbed and bear six ribs to a whorl, with round-bottomed grooves between them, each rib being slightly in front of that on the previous whorl. These ribbed earlier whorls are also spirally striate and bear five or six raised spiral ribs. The ribs and striae disappear on the third whorl from the last. The sides of the last three whorls are flat or very slightly concave, each one having a gentle concavity below the suture. The latter whorls have a concave platform. The body whorl contracts abruptly to form a rostrum, which is considerably produced, but whose point is missing.

Dimensions.—Length originally about 83 mm.; diameter of body whorl 37 mm.

Locality.—Spring Mount, one specimen with an *Ostrea* and two small *Carolias* on it.

Remarks.—Among the Paris forms illustrated in *Iconographie* it most resembles *C. maximus* Desh. from the Lutetian, but the spiral striae continue on to the third whorl from the last in the Paris shell, and the rostrum seems to attenuate more rapidly and the last whorl to be more globose. Also the Paris form is a considerably larger species.

It bears some resemblance to *C. goniophorus* Bellardi, which occurs in the Upper Mokattan beds and is figured by Oppenheim,[2] but in the Jamaican form the platform below the suture is much more excavated and the ribs on the earlier whorls more pronounced. In the Scotland beds of Barbados there is a rather similar tabulate species which has not yet been described but is rather like *C. tabulata* Dickerson,[3] from the Marysville Buttes beds of California.

Mausseneția cossmanni sp. nov. (Pl. XIV, Fig. 3.)

Description.—Shell thin, consisting of about six whorls, the spire conical, the last whorl is gently inflated for some distance below the suture and is longer than the spire. The whorls are gently rounded,

[1] *Q.J.G.S.*, vol. lxi, 1905, p. 161, pl. xvii.
[2] *Palæontographica*, Bd. xxx. Abt. iii, p. 315, pl. xxiii, fig. 6.
[3] Univ. California Publ., vol. vii, No. 12, 1913, p. 283, pl. xii, fig. 7.

the suture shallow. Lip expanded and continued backwards on to the penultimate whorl, the margin is broken away, so the outline of the lip of the perfect shell cannot be ascertained. The surface is decorated with faint spiral furrows, which are sometimes scarcely visible on the whorls, but widen out towards the lip, where the reare about fifteen of them.

Dimensions.—The figured specimen has been 98 mm. long and 56 mm. in diameter of body whorl.

Locality.—Railway line between Cambridge and Catadupa; Spring Mount, etc.

Remarks.—The decoration on the whorls is rather similar to that on *M. staadti* Cossm., from the Thanetian of Châlons, but the spire is shorter in the Jamaican shell. It bears some resemblance to *M. dimorphospira* Cossm.,[1] from the Upper Ranikot beds, but has a more stumpy spire and lacks the angulation on the body whorl below the suture. Douvillé records *M. dimorphospira* also from the Soudan.[2]

In some ways it recalls *Pugnellus digitatus*[3] Noetling, from Baluchistan, where it occurs in the Mari Hills in supposed Maestrichtian beds. Judging from the illustrations one would suspect that several Eocene fossils have been included in this fauna.

Turbinella (*Eovasum*) sp. (Pl. XVII, Fig. 7.)

Description.—A cast consists of five whorls, all of which are provided with blunt tubercles round the periphery and become broader and more prominent on the body whorl, where they are prolonged down the sides for some distance as low broad ribs. The spire is rather elevated and the suture deep in the cast.

Dimensions.—Length 64 mm., diameter 48 mm.

Locality.—Chapelton district; Spring Mount, where several badly crushed casts occurred.

Remarks.—I have not been able to ascertain from these badly preserved examples whether the shell was provided with columellar folds. Except for this the cast illustrated agrees well with a cast of *Eovasum frequens* Mayer-Eymar from Senegal illustrated by Douvillé,[4] except that the spire in the Jamaica shell is more elevated. Douvillé discusses at length the affinities of this shell, which Oppenheim[5] records as *Turbinella frequens* from the Mokattam beds.

Gisortia, cf. *murchisoni* d'Archiac. (Pl. XIV, Fig. 1.)

Description.—Whorls about five, spire low, not covered by the lip, suture fairly deep, body whorl inflated tapering gradually and rather pointed anteriorly. Lip channelled and projects some

[1] *Pal. Ind.*, New Series, vol. iii, mem. i, 1909, p. 51, pl. iv, figs. 26–8; pl. viii, figs. 4 and 4*a*.

[2] *Bull du Comité de l'Afrique Occidentale Francaise*, 1920, p. 152, pl. i, figs. 6, 7.

[3] *Pal. Ind.*, Ser. xvi, vol. i, pt. 3, 1897, p. 61, pl. xvi, figs. 5–7.

[4] "l'Eocene au Soudan et au Sénégal," *Bull. Comité d'Etudes de l'Afrique Occidentale Francais*, 1920, p. 147, fig. 5.

[5] *Palæontogr.*, vol. xxx, abt. iii, p. 318, pl. xxiv, figs. 1–7.

distance behind the spire. Outer lip fairly straight, rounded and thickened.

Dimensions.—Length 130 mm., breadth 92 mm., height 82 mm.

Locality.—Spring Mount, two specimens.

Remarks.—This specimen, which is partly in the form of a cast, is larger and more elongated than *G. brevis* Douvillé from Senegal and the Soudan. It rather resembles casts of *G. murchisoni* from the Upper Ranikot, figured by Cossmann and Pissarro, but is more tapering and pointed anteriorly. It resembles figures of a cast of the same species as regards the attenuation of the anterior portion of the shell, but the posterior part of the last whorl seems less expanded than in the Indian shell, which comes from yellowish white limestone with small nummulites and alveolinas of the Chain of the Hala.[1]

Gisortia sp. (Pl. XIV, Fig. 2.)

Description.—Whorls about five, spire rather elevated, blunt, the channelled posterior lip touches the later whorls of the spire, but does not hide it, and projects slightly beyond it. Whorls well rounded, the body whorl much inflated.

Dimensions.—Original length probably 140 mm., width 95 mm., height 75 mm.

Locality.—Spring Mount, one specimen, the anterior part missing, but part of the shell remaining.

Remarks.—This specimen may be rather closely related to *G. postalensis* Oppenheim.[2] Both these Jamaican specimens are poorly preserved, but they show that at least two species of *Gisortia* occur in the Yellow Limestone. Though the lip is channelled and projects posteriorly, in neither specimen does it grow over the spire as it does in the three forms known from the Paris Eocene.

Dolium jamaicense sp. nov. (Pl. XVIII, Fig. 7.)

Description.—Shell of five whorls, moderately thick, spire rather elevated, suture fairly deep and broad, body whorl large and inflated, rather more than twice the height of the spire. Aperture oval, the lip sharp expanded and partly upturned and reflected. The anterior channel is slight, the umbilicus rather broad and deep, partly covered by a thin callosity in the adult shell. The early whorls are nearly smooth, but the body whorl develops a series of about 15 parallel spiral shallow grooves which are rather irregularly spaced and vary in width but are all about the same depth. These are very faint for some distance below the suture.

Dimensions.—The largest specimen is 65 mm. high and 66 mm. broad.

Locality.—Spring Mount, eight specimens.

Remarks.—Species of *Dolium* are rare in the Eocene, the Paris Basin does not seem to have any. L. V. Dalton records one from

[1] d'Archiac and Haime, *Nummulitique de l'Inde*, 1853, pl. xxxiii, figs. 4 and 4*a*.

[2] *Palæontogr.*, bd. xliii, 1897, p. 197, pl. xvi, figs. 1 and 1*a*.

Burma with ornamentation rather similar to this one, but with higher spire and less inflated body whorl.

Heligmotoma sp. (Pl. XV, Fig. 8.)

Description.—A cast consists of four whorls, the spire is low, the last whorl is inflated and strongly keeled along the periphery below the spire, the earlier whorls are rounded, anterior channel rather produced. There are traces of columellar folds.

Dimensions.—Height 32 mm., diameter 29 mm.

Locality.—Railway between Cambridge and Catadupa, one specimen.

Remarks.—It resembles a cast of *H. libycum* Oppenheim from the Libyan beds.[1] The affinities of this and allied genera is discussed fully by Oppenheim and Douvillé.

Rostellaria (?) sp. (Pl. XV, Fig. 7.)

Description.—Shell of six whorls, the spire bluntly pointed, the earlier whorls increase rapidly and are inflated and rounded, the suture rather deep. The body whorl is only a little wider than the penultimate, and narrows anteriorly. The anterior channel is narrow and pointed. Only the anterior portion of the outer lip remains, this spreads out and is slightly reflected, and is decorated with nine or ten rounded radial ridges, with shallow intervening sulci. This decoration seems to be confined to the region of the aperture, the rest of the shell being smooth.

Dimensions.—Length 37 mm., diameter 22 mm.

Locality.—Spring Mount.

Remarks.—The general shape is rather that of *R. turgida* Desh. of the Cuisian, but the penultimate whorl is more swollen and the margin more alate.

Rimella, cf. *Prestwichi* d'Arch. and Haime. (Pl. XVI, Fig. 10.)

Description.—Shell of about seven whorls, the ribs are thin and irregularly spaced, and seem to cover all the whorls. The whole surface is also covered by fine spiral grooves. The lip and spire are largely missing, making identification with this species[2] rather uncertain.

Dimensions.—Length 44 mm., breadth 23 mm.

Locality.—Bed of stream 3 miles north of Cambridge with *Carolia*, etc.

Rimella spp. (Pl. XVI, Figs. 11, 12, 13.)

Casts of shells of more or less irregular growth (Figs. 11 and 12) resemble casts of *R. libyca* Oppenheim[3] from the Libyan beds of Egypt. They are chiefly from Spring Mount and measure 29 mm. in length.

[1] *Palæontogr.*, bd. xxx, abt. iii, 1906, pl. xxiii, fig. 2.

[2] *Nummulitique de l'Inde*, 1853, p. 312, pl. xxx, figs. 7 and 8; and Cossmann and Pissarro, "Mollusca of Ranikot Series," *Pal. Ind.*, vol. iii, mem. 1, p. 46, pl. iv, figs. 21 and 22.

[3] *Palæontogr.*, bd. xxx, abt. iii, 1906, p. 295, pl. xxv, figs. 34–6.

Casts of another species (Fig. 13) are common at Spring Mount and around Cambridge. They may be related to *R. fissurella* Linn., a form common in the Calcaire Grossier of Grignon.

Trochus (*Monodonta*), cf. *Zignoi* Bayan. (Pl. XVI, Fig. 14.)

Description.—Shell of about five whorls, fairly thick, suture deep, whorls rather rounded, decorated with about 10 concentric spiral ridges, which are most prominent on the periphery of the body whorl, and finer on the base and just below the suture. The umbilicus is partly concealed by a slight callosity.

Dimensions.—Height 17 mm., diameter 15 mm.

Locality.—Spring Mount, five specimens.

Remarks.—These are poorly preserved, but resemble rather closely *T. zignoi* from Monte Postale.[1]

Conus sp.

Several cone shells in a poor state of preservation, often crushed, occurred at Glasgow and more rarely at Spring Mount. One of them is about 34 mm. long and 26 mm. in diameter. They all have a low spire and resemble a specimen of *C.* cf. *brevis* Sow., illustrated by Cossmann and Pissarro from the uppermost Ranikot beds.

Turritella sp.

A large *Turritella* in the form of a cast occurred at Spring Mount. It has the general shape of *T. hybrida* Desh. of the Cuisian of the Paris Basin, or of *T. infrarimata* Coss. and Piss. of the Upper Ranikot beds, but scarcely any of the shell remains on it. It must have been about 135 mm. long.

Hipponyx sp. (Pl. XVI, Fig. 6.)

Description.—Shell tapering slowly, strongly bent, with a broad shallow sulcation on the left posterior side. The growth ridges are well marked below the apex, and fine radial striae are developed towards the margin.

Dimensions.—Height 20 mm., diameter at aperture 24 mm.

Locality.—Bed of stream 3 miles north of Cambridge, with Carolia; one specimen.

Remarks.—This shell rather resembles one I have from Monte Postale, but which is apparently not described in Oppenheim's monograph. It is not like any of the Paris Basin forms, and may be a new species.

Pseudoheligmus (*?*) *jamaicénsis* sp. nov. (Pl. XVIII, Figs. 1-3.)

Description.—Shell thick, unattached, valves inflated, the left more so than the right. Outline variable, some specimens (Fig. 1) are subquadrate, others (Fig. 2) oblong and downwards or anteriorly produced. Beaks close together, pointed and anteriorly directed: in some specimens the beak of the left valve is considerably produced

[1] *Palæontogr.*, bd. xliii, 1897, p. 164, pl. xix, figs. 7 and 7*a*.

above the hinge line and bent forwards. Posterior wing is rather alate in some specimens and there is a hollowed lunule in front of the beaks. The hinge area is short and longitudinally striate with a median bowl-like excavation just below the apex (Fig. 2), a corresponding rounded protuberance of the opposite valve seems partly to fit into this excavation, the excavation and protuberance seems to occur indifferently in either right or left valves. Except for this peculiarity the hinge approximates to the *Vulsella* type.

The surface of the shell for a greater or less distance below the beaks is decorated with foliaceous growth lines, which at a later stage gradually develop into long matted foliaceous flat or scale-like protuberances. These form a thick layer, which tends to break away in some parts, leaving the foliaceous growth lines as they are seen round the beaks.

Dimensions.—An uncrushed specimen (Fig. 1) is 42 mm. high, 40 mm. wide, and 31 mm. in diameter of both valves. A larger left valve is 62 mm. high and 54 mm. wide.

Locality.—Spring Mount, where I collected about 10 specimens; Glasgow, etc. It is a common fossil, but often badly crushed.

Remarks.—At first sight this shell suggests a Chama, but the hinge is quite different and it is apparently unattached. I am much puzzled as to its affinities, and it may be a new genus. In the general aspect of the hinge line it resembles *Vulsella* (*Pseudoheligmus*) *nigeriensis* R. B. Newton sp. Douvillé [1] illustrates several specimens of this shell from Tamaské in the Soudan. It is inequivalve and irregular in outline, but the surface is merely undulated and seems to have none of the foliaceous growths of the Jamaican shell.

Oppenheim [2] figures several *Vulsellæ* of aberrant shapes from the Libyan and Mokattam beds of Egypt, some of which, especially *V. chamæformis* Mayer-Eymar, may be related to the present shell. He also discusses the hinge apparatus of the Egyptian Eocene *Vulsellæ*, which seems to present abnormalites, as does this Jamaican shell.

Carolia. cf. *placunoides* Cantraine. (Pl. XVII, Fig. 4.)

Some of the Caroliæ from the Yellow Limestone, with a short and crooked hinge line, which often gradually merges into the general irregularly rounded outline, bear so close a resemblance to the Egyptian forms that I think the species must be identical. The area in these specimens is less well seen than in those that have a straight hinge line. The example figured, which measures 64 mm. in height, and the same in breadth, is very like a specimen from the Upper Mokattam beds of the Fayum, which Oppenheim illustrates.[3] He and other authors deal at length with the curious hinge and

[1] *l'Eocene au Soudan et au Sénégal*, 1920, p. 155, pl. iii, figs. 5, 6, and 7.
[2] *Palæontogr.*, bd. xxx, abt. iii, 1903, p. 73, pl. iv, fig. 9 and 9*a*.
[3] *Palæontogr.* 1906, bd. xxx, abt. iii, p. 208, pl. xxvi, fig. 19.

attachment apparatus of this shell. Two small *Carolia* are attached to the rostral portion of the *Clavilithes* figured on Pl. XV, Fig. 9.

Carolia jamaicensis W. H. Dall. (Pl. XVII, Fig. 5.)

1903. "Tertiary fauna of Florida": *Trans. Wagner Free Inst. Science Philadelphia*, vol. 3, pt. 4, p. 776, pl. 33, fig. 21.

Dall figures a specimen consisting of two valves slightly displaced, the anterior portion of the shell missing. The hinge area is well indicated in his figure. He describes the shell as of moderate size and irregular growth, extremely compressed, thin, normally suborbicular, the upper valve slighly convex, with inconspicuous beak and no clearly defined cardinal area; the surface of both valves covered with fine vermicular close-set radial striae and threads.

This description agrees, except as regards the cardinal area, which is generally well seen, with numerous examples I collected in Jamaica. Dall does not compare his specimen with the Egyptian examples, but among my specimens there are intermediate stages connecting the form with a long hinge line (Fig. 5) and marked area with those in which the hinge line merges into the general outline. (Fig. 4)

Locality.—Caroliæ of all sizes up to a diameter of 100 mm. occur massed together on the railway line between Cambridge and Catadupa and at other places around Cambridge where they seem to occupy beds definitely above those with the gigantic *Cerithia* and other fossils. At Spring Mount, *Carolia* comes in rather high in the sequence, some time later than *Velates*, but it accompanies *Velates* and *Cerithium giganteum* nearly to the top of the Yellow Limestone.

Lucina (*Pseudomiltha*), cf. *gigantea* Desh.

Internal casts of almost circular outline with medially situated beaks are very common at Spring Mount, Glasgow, and other localities, and may belong to this well-known Paris Basin Lutetian species. Several species of gigantic Lucinæ occur, but rarely except as casts.

Lucina (*Pseudomiltha*) sp. (Pl. XVII, Fig. 6.)

Description.—Shell rather irregularly grown with anteriorly situated beaks. The posterior upper portion is flattened and rather alate, and the wing is occupied by a rather pronounced radial groove with a smaller one below it, which pass from behind the beak to the posterior margin.

Dimensions.—Length 56 mm., height 50 mm., diameter 22 mm.

Locality.—Spring Mount.

Remarks.—It rather resembles *L. mutabilis* Lam. from the Lutetian of Villiers, but the posterior wing is more alate and more strongly grooved and the Paris shell has a more produced and rounded lower margin.

C. T. T. *photo.*

YELLOW LIMESTONE MOLLUSCA, JAMAICA.

To face p. 360.

DUP

Lucina (*Pseudomiltha*) sp. (Pl. XIV, Fig. 5.)

Description.—Shell rather longer than high, the beaks broad and situated somewhat in front of the median line, directed very slightly forwards.

Dimensions.—Length 113 mm., height 99 mm., diameter 42 mm.

Locality.—Spring Mount.

Remarks.—This specimen bears some resemblance to *Lucina pseudogigantea* Oppenheim from Monte Postale,[1] but in that form the beaks are smaller and more anteriorly directed.

Crassostrea, cf. *soudanensis*, Douvillé. (Pl. XIV, Fig. 6.)

Description.—Shell thick, outline subtriangular, the attached valve tapering above the hinge margin, the ligament area much prolonged with a median sunken depression marked by very fine vertical striae and bordered by rounded raised areas. The lateral and median areas are marked by fine concentric growth lines. Exterior surface of larger valve foliaceous, the foliation showing on either side of the ligamental area. The free valve has a small beak rather excentrically placed, the surface irregular, slightly concave in parts, smooth or with rather foliaceous growth lines.

Dimensions.—Length of large valve 114 mm., diameter about 65 mm.

Locality.—Spring Mount.

Remarks.—The figured example consists of one of three specimens joined back to back. It is very similar to *C. soudanensis*,[2] but the Jamaican shell has a less elongated beak and the median area more marked and more sunken. Mr. R. B. Newton,[3] in describing a rather similar form from Nigeria, *C. lugardi*, gives an enumeration and discussion of the various known forms of these "*longirostri*-form" oysters.

Ostrea (*Pycnodonta*) sp. (Pl. XVI, Fig. 5.)

A small specimen of the convex valve of one of the so-called "Gryphæa" of the Eocene, with an anterior wing divided from the rest of the shell by a shallow groove, is ornamental with a series of shallow irregular concentric furrows. It may be the young of a form similar to *P. rarilamella* Desh., race *Senegalensis*, figured by Douvillé from Senegal. It is rather similar to *P. cymbiola* Desh. from the Bartonian of Le Fayel. It is 23 mm. high and long.

Locality.—Spring Mount.

Ostrea sp. (Pl. XVII, Fig. 2.)

Description.—Shell thick, attached valve longer than broad, surface very irregular, not strongly foliate, the area is triangular

[1] *Palæontogr.*, bd. xliii, 1897, p. 154, p. xii, fig. 3.

[2] *l'Eocene au Sénégal et au Soudan*, p. 164, pl. vi, fig. 14.

[3] "Geol. Survey of Nigeria," *Bull No.* 3, 1922, p. 62, pl. vi, fig. 1; pl. vii, fig. 1; and pl. viii, fig. 1.

and high with only a slightly sunken median portion. The free valve is elongated flat and ornamented with growth foliations.

Dimensions.—Length 58 mm., width 39 mm.

Locality.—Spring Mount, several examples.

Remarks.—This form may be related to *O. cariosa* Lam. from the Lutetian of Chaumont, but that form has a more sunken area. It seems also to resemble *O. achersoni* Mayer-Eymar from the Libyan beds of Egypt.[1]

Ostrea multicostata, Desh. (Pl. XVI, Fig. 1 and 1*a*.)

Some of the numerous ribbed oysters of the Yellow Limestone closely resemble a specimen of the above species from the Soudan which Douvillé illustrates.[2] They are very common in the higher beds at Spring Mount and around Cambridge with *Carolia* and other fossils. Oysters with the right valve similarly striate, but broader in outline and with a fairly large attachment area, also occur. One of them is figured on Pl. XVI, Fig. 4, and closely resembles specimens of *O. cubitus* Lam., var. *pancicostata*, illustrated by Oppenheim[3] from the Upper Mokattam beds of Egypt. An oyster with a plicate lower valve with a large attachment surface and an arched free valve, apparently related to *O. plicata* Sol., is seen attached to the *Clavilithes* on Pl. XV, Fig. 9.

Ostrea, cf. *sparnacensis* Defr. (Pl. XVI, Figs. 2 and 3.)

Description.—The attached valve is more or less elongated and strongly arched, the beaks pointed and twisted either to the right or left. Hinge area high with a slightly sunken median area and a gently rounded portion on either side. Surface with foliaceous growth lines. The free valve is elongated, gently rounded, and smooth, except that the growth lines become rather foliaceous at the margins.

Dimensions.—Length 51 mm., width 22 mm.

Locality.—Common around Cambridge with *Carolia* and other fossils.

Remarks.—This oyster seems to resemble the above species from the *Sparnacian* of Sinceny. I can trace nothing like it from Egypt or Senegal.

Spondylus sp. (Pl. XVIII, Fig. 4.)

Description.—Shell subcircular in outline, the valves rather inflated, both about equally so, with small anterior and posterior wings. Beaks small and close together. The attached valve becomes foliaceous round the area of attachment, which is small in extent. The surface of the free valve bears two or three low irregular ridges, and the surface of both valves is decorated with numerous fine rounded rather wavy ridges that diverge from the

[1] Oppenheim, *Palæontogr.* xxx, bd. iii, 1903, p. 38, pl. ii, figs. 17 and 17*a*.
[2] *l'Eocene au Sénégal et au Soudan*, 1920, pl. iv, fig. 2.
[3] *Palæontogr.* xxx, abt. iii, 1903, p. 27, pl. xi, figs. 9 and 9*a*.

beaks to the margins, near which finer ribs are intercalated between them. A very few short spires seem to be developed.

Dimensions.—Height and width 30 mm., diameter 17 mm.

Locality.—Spring Mount, one specimen.

Remarks.—Douvillé figures a species which he calls *S. quadricostatus*[1] from Senegal, which has similar rounded subequal valves, but it is much larger and the radial ribs seem to be straighter and broader.

Modiola sp. (Pl. XV, Fig. 11.)

Description.—Shell thin, with rather marked regular growth lines. Beaks small, not quite terminal. A rather inflated rounded ridge passes from behind the beaks to the lower posterior margin, where it merges in the rounded surface of the shell. The upper posterior margin is rather alate, the wing having a broadly rounded outline; the anterior margin below the beak is gently rounded. The hinge seems to have a long posterior tooth.

Dimensions.—The largest example is 74 mm. long, 37 mm. high, and 25 mm. thick.

Locality.—Spring Mount, two specimens.

Remarks.—It is rather similar to *M. postalensis* Oppenheim,[2] but in the Jamaican shell the wing is more alate, the shell narrows more anteriorly and the ridge is broader and lower. *M. subcarinata* Lam. from the Lutetian of Grignon has broader and less anterior beaks but a similar rounded surface.

Cardium (*Trachycardium*) sp. (Pl. XIV, Fig. 4.)

Description.—Shell thin and inflated, beaks large, close together, the anterior and lower outline regularly rounded, posterior margin rounded, rather produced. There are about 34 ribs round the margins, which are prominent, but disappear on the cast towards the beaks.

Dimensions.—Height 100 mm., length 98 mm., thickness 72 mm.

Locality.—Spring Mount; the railway line south of Cambridge, where a specimen occurred in hard crystalline Yellow Limestone high up close under the White Limestone.

Remarks.—These large Cardiidæ are nearly always casts, they have the general shape of *C.* (*T.*) *subfragile* D'Orb. of the Cuisian of the Paris Basin, but in that form the ribs are more numerous and less prominent. Other equally large Cardiidæ with a much thicker shell strongly ridged near the middle, broader beaks, and fewer and stronger ribs occur as rough casts. The poor condition of those I collected does not allow a satisfactory determination.

Cardium (*Trachycardium*) sp. (Pl. XVII, Fig. 9.)

Description.—Shell thin, inflated especially near the umbones, the anterior and lower margin semi-circular, posterior margin

[1] *l'Eocene au Soudan et au Sénégal*, 1920, p. 158, pl. iii, fig. 8.

[2] *Palæontogr.*, bd. xliii, 1897, p. 146, pl. xix, fig. 16.

rounded and rather produced. The ribs are broad and flattened on the posterior part and separated by shallow furrows, narrow and very fine on the median portion but coarser on the anterior part. On the median part below the beaks the shell is nearly smooth.

Dimensions.—Height 41 mm., length 40 mm., thickness 30 mm.

Locality.—Bed of stream 3 miles north of Cambridge, with *Carolia*, etc.

Remarks.—This shell has the general appearance of *C. gratum* Defr., from the Lutetian of Vaudancourt, but the umbo is broader and more inflated and smoother on the medial portion in the Jamaica shell. It may be related to the group of *C. dalli* Dickerson of the Marysville Buttes, and *C. cooperi* Gabb of the Tejon in the Californian Eocene, but both these seem to have narrower beaks.

Cardium (*Loxocardium ?*) sp. (Pl. XVII, Fig. 8.)

Description.—Shell thin, valves closed all round, beaks moderately inflated, medially situated. There is a slight posterior wing, and the posterior area is scarcely differentiated from the rest of the surface. Surface is decorated with fine close-set radiating ribs which are cut up into scaly protuberances.

Dimensions.—Height 38 mm., length 39 mm., thickness 29 mm.

Locality.—3 miles north of Cambridge.

Remarks.—In general outline and ornamentation it recalls specimens of *C. obliquum* Lam., but is a much larger species than the Paris form.

Corbis jamaicensis sp. nov. (Pl. XVIII, Fig. 5.)

Description.—Shell fairly thick, beak almost medially situated, the surface rather flattened near the beak. Anterior margin rounded and somewhat produced, lower margin gently rounded, posterior margin gently curved and rather truncated. The ornamentation consists of about 34 concentric prominent rounded ribs, which become widely spaced near the beaks and rather close together at the lower margin. Very fine radial ribs occur on the furrows forming a reticulate ornamentation.

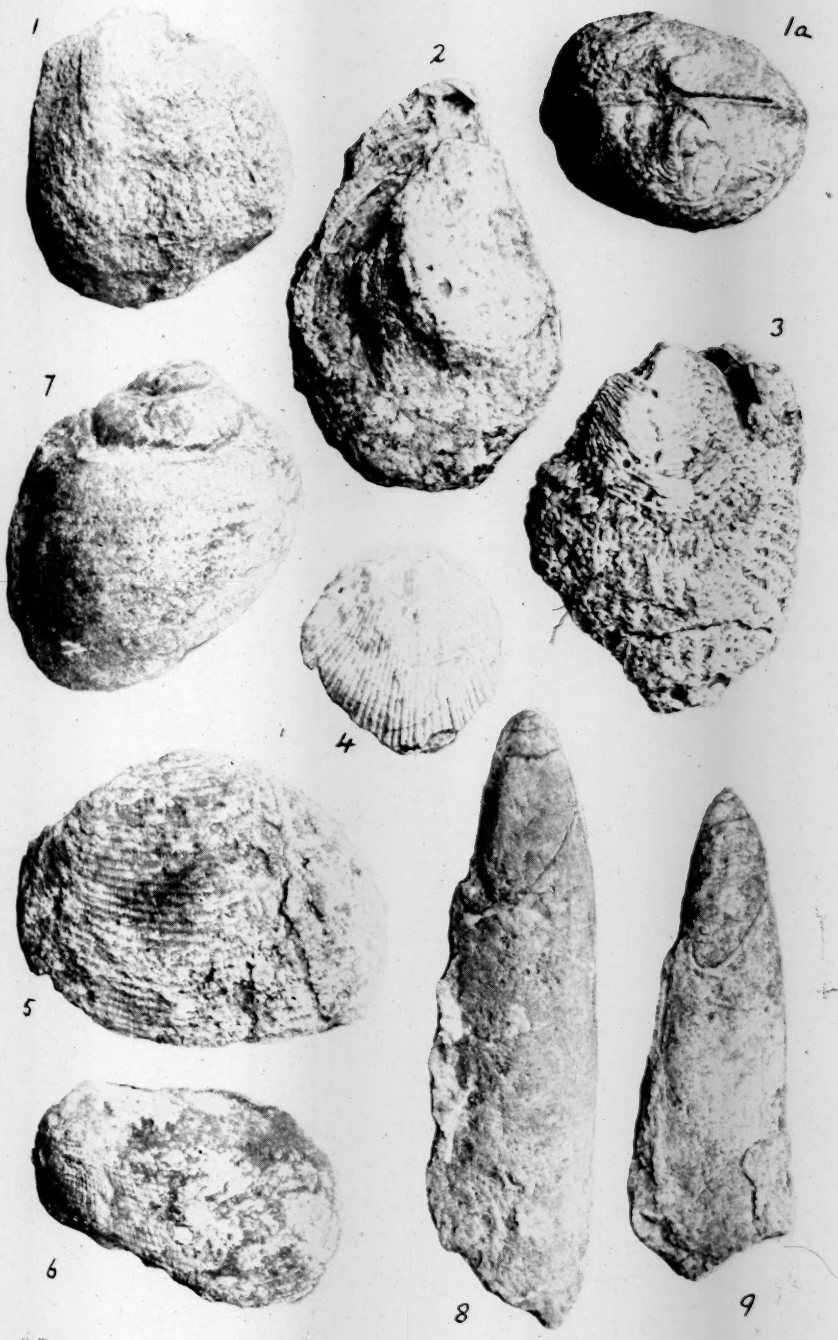
Dimensions.—Height 40 mm., length 53 mm., depth of valve 17 mm.

Locality.—Spring Mount, one specimen, a right valve.

Remarks.—Among the Paris Basin forms, *C. subpectunculus* d'Orb. is a much larger and thicker shell, while *C. lamellosa* Lam. is much flatter and has sharper ribs. From Monte Postale I have a specimen of *C. major* Bayan, but it is heavier and thicker, though it has similarly rounded concentric ribs, the radial ribs are scarcely seen except on the anterior slope.

R. B. Newton illustrates a fragment of *Fimbria*, cf. *lamellosa* Lam., from the Eocene of Somaliland,[1] with widely spaced ribs

[1] *Q.J.G.S.*, vol. lxi, 1905, p. 172, pl. xxi, fig. 9.



C. T. T. photo.

YELLOW LIMESTONE MOLLUSCA, JAMAICA.

To face p. 364.]

DUP

and well-marked radial riblets. A very imperfect specimen, *C. laxilamella* Mayer-Eyman, from the Libyan beds of Egypt, figured by Oppenheim,[1] has a rather similar ornamentation to the present specimen.

Barbatia sp. (Pl. XVIII, Fig. 6.)

Description.—Beak rather anterior, small and low, the shell widening posteriorly, the posterior margin rounded. The ornamentation consists of shallow concentric growth interruptions regularly spaced, on the anterior and median part of the shell these are crossed by fine posteriorly directed radial ribs, which extend from below the beak to the lower margin.

Dimensions.—Length 47 mm., height 30 mm.

Locality.—Spring Mount, one left valve.

Remarks.—It resembles in shape *B. magellanoides* Desh. of the Paris Eocene. R. Arnold figures a rather similar form, *B. morsei* Gabb,[2] from the Tejon of California, but in that the beak is less anterior and the radial ribs are considerably stronger and cover more of the surface.

Tellina (*Macaliopsis*), cf. *reticulata* Bellardi. (Pl. XV, Fig. 12.)

Description.—Shell wider than high, beaks pointed, situated behind the median line and rather anteriorly directed. Plane of the valves rather twisted to the right. The surface is decorated with fine sharp close-set concentric striae.

Dimensions.—Length 31 mm., height 24 mm.

Locality.—Spring Mount.

Remarks.—Both the cast and the surface decoration resemble that of specimens of *T. reticulata* from the Upper Mokattam beds of the Fayum, illustrated by Oppenheim.

Cytherea (*Meretrix*) sp. (Pl. XV, Fig. 10.)

Two or three species of Cytherea occur at Spring Mount and elsewhere, some of them have the shape of *M. distincta* Desh., and have fairly anterior beaks. Another specimen with the shell on it (Fig. 10) is well inflated, and has the beak rather in front of the median line. Except that it is more inflated, it resembles *M. nitidula* Lam., which occurs in the Cuisian, Lutetian, and Bartonian of the Paris Basin. It is 39 mm. long, 31 mm. high, and 23 mm. across the valves.

Venus sp. (Pl. XV, Fig. 13.)

A small species 19 mm. long and 15 mm. high, with about 18 concentric ridges, has a general resemblance to *V. blandiana* Guppy, which he records from the Miocene of Jamaica, but gives no locality.[3] The present shell may, however, be longer and less

[1] *Palæontogr.*, bd. xxx, abt. iii, 1903, p. 152, pl. ix, fig. 2.

[2] "Palæontology of Coalinga District": *U.S. Geol. Surv. Bull.* 396, 1909, pl. iii, fig. 8.

[3] Geol. Mag., Dec. II, Vol. I, Nos. 9 and 10, 1874, p. 12, Pl. XVII, Fig. 8.

orbicular. It occurs plentifully in a pebbly bed with *Ostrea multicostata* rather high in the Spring Mount section.

EXPLANATION OF PLATES.

(*All specimens are in the Author's collection.*)

PLATE XIV. All figures about one-half natural size.

FIG.
1.—*Gisortia*, cf. *Murchisoni* d'Archiac. Spring Mount.
2.—*Gisortia* sp., spire and part of body whorl. Same locality.
3.—*Maussenetia Cossmanni* sp. nov. Same locality.
4.—*Cardium* (*Trachycardium*) sp. Same locality.
5.—*Lucina* (*Pseudomiltha*) sp. Same locality.
6.—*Crassostrea* cf. *soudanensis* Douvillé. Same locality.

PLATE XV. All figures approximately natural size.

FIG.
1.—*Velates schmideliana* Chem., smooth type. Spring Mount.
2.—ditto ; smaller specimen with slight columellar groove. Same locality.
3.—ditto ; example with deep groove, the genus " Provelates " of Noetling. Same locality.
4.—*Cypraea* (*Cypraedia*) *subelegans* sp. nov., ventral aspect. Same locality.
5.—*Cypræa*, cf. *elegans* Defr., side aspect. Same locality.
6.—ditto, dorsal aspect of another specimen. Same locality.
7.—*Rostellaria* (?) sp. Same locality.
8.—*Heligmotoma* sp. Railway line between Cambridge and Catadupa.
9.—*Clavilithes jamaicensis* sp. nov., with *Ostrea*, cf. *plicata* Sol. attached to the right side and two young *Carolia* attached lower down. Spring Mount.
10.—*Cytherea* (*Meretrix*) sp. Same locality.
11.—*Modiola* sp. Same locality.
12.—*Tellina* (*Macaliopsis*), cf. *reticulata* Bellardi. Same locality.
13.—*Venus* sp. Bed of stream, 3 miles north of Cambridge.

PLATE XVI. All figures approximately natural size.

FIG.
1 & 1a.—*Ostrea multicostata* Desh., right and left valves of one specimen. Spring Mount.
2.—*Ostrea*, cf. *sparnacensis* Defr., right valve. Three miles north of Cambridge.
3.—ditto, left valve of another specimen. Same locality.
4.—*Ostrea*, cf. *cubitus* Lam., var. *paucicostata*, right valve. Spring Mount.
5.—*Ostrea* (*Pycnodonta*) sp. convex valve. Same locality.
6.—*Hipponyx* sp. Bed of stream 3 miles north of Cambridge.
7.—*Xenophora* sp. ; side aspect. Spring Mount.
8.—ditto, apical aspect of another specimen. Same locality.
9.—ditto, ventral aspect of a third specimen. Same locality.
10.—*Rimella*, cf. *Prestwichi* d'Archiac. Three miles north of Cambridge.
11.—*Rimella*, cf. *libyca* Oppenheim. Same locality.
12.—ditto, another internal cast. Spring Mount.
13.—*Rimella*, cf. *fissurella* Linn., internal cast. Same locality.
14.—*Trochus* (*monodonta*), cf. *Zignoi* Bayan. Same locality.
15.—*Ampullospira*, cf. *Oweni* d'Archaic, specimen with spire broken. Same locality.
16.—ditto, smaller specimen. Same locality.
17.—*Ampullina limnæoides* sp. nov. Three miles north of Cambridge.
18.—ditto, another specimen. Same locality.
19.—*Ampullina* (*Cronmium* ?) sp. Railway line one mile south of Cambridge.
20.—*Ampullina* sp. Spring Mount.
21.—*Ampullina*, cf. *Spharica* Desh. Railway line one mile south of Cambridge.
22.—*Ampullospira*, cf. *Levesquei* d'Orb. Spring Mount.
23.—ditto, another more conical example. Same locality.

PLATE XVII.

FIG.
1.—*Campanile*, cf. *giganteum* Lam. Rather under one-third natural size. Tangle River valley.
2.—*Ostrea*, cf. *cariosa* Desh. Two-thirds natural size. Spring Mount.
3.—*Ampullina*, cf. *depressa* Lam. Two-thirds natural size. Same locality.
4. *Carolia*, cf. *placunoides* Cantraine. Two-thirds natural size. Same locality.
5.—*Carolia jamaicensis* Dall. Two-thirds natural size. Same locality.
6.—*Lucina* (*Pseudomiltha*) sp. Two-thirds natural size. Same locality.
7.—*Turbinella* (*Eovasum*) sp., internal cast. Two-thirds natural size. Chapelton district.
8.—*Cardium* (*Loxocardium* ?) sp., natural size. Three miles north of Cambridge.
9.—*Cardium* (*Trachycardium*) sp., natural size. Locality near the last.

PLATE XVIII. All figures approximately natural size.

FIG.
1.—*Pseudoheligmus* (?) *jamaicensis* sp. nov., right valve. Spring Mount.
1*a*.—ditto, same specimen, apical view of both valves in apposition.
2.—ditto, specimen with both valves, rather crushed, showing the *Vulsella*-like arrangement of the hinge of left valve. Same locality.
3.—ditto, view of a crushed left valve of a specimen with both valves in apposition, but showing well the surface ornamentation. Same locality.
4.—*Spondylus* sp. Same locality.
5.—*Corbis jamaicensis* sp. nov., a right valve. Same locality.
6.—*Barbatia* sp. Same locality.
7.—*Dolium jamaicense* sp. nov. Same locality.
8.—*Terebellum subdistortum* sp. nov. Same locality.
9.—ditto, another specimen with more complete spire. Same locality.

The Base of the Devonian, with special reference to the Welsh Borderland.

By L. DUDLEY STAMP, B.A., D.Sc., A.K.C., F.G.S.

(*Continued from p. 336.*)

3. *South Staffordshire—Saltwells and Trimpley Inliers.*

There is a tiny but very interesting inlier of Upper Ludlovian and Lower Downtonian rocks at Saltwells, near Stourbridge. It has been described in detail by Messrs. W. W. King and W. J. Lewis,[1] and will not be redescribed here.

It should be noted, however, that the "Old Red Sandstone" of that paper is in reality Red Downtonian. This fact was realized by Mr. King when he examined red strata of a similar horizon in shafts of collieries and other sections in the vicinity of the South Staffordshire Coalfield and found in them fish-remains of Downtonian species.[2] Only a few dozen feet of these Red Downtonian beds are seen (above the Temeside Shales) in the Saltwells Inlier, as they are overlain by the local base of the Coal Measures. An interesting account of the pre-Coal Measure folding of the region

[1] King & Lewis, GEOL. MAG., 1912, pp. 437 et seq.
[2] King & Lewis, *Proc. Birmingham Nat. Hist. and Phil. Soc.*, vol. xiv, 1917, p. 90.

has recently been given by Mr. King.[1] It was in this paper that he suggested the term Dittonian as used in the present note.

Complementary to the Saltwells Inlier is the Inlier of Trimpley, on the Kidderminster-Bridgnorth road. This area has been mapped with great care by Mr. King, but his results are not yet published.[2] Only the higher part of the Downtonian is exposed, but the succession can be linked on to that at Saltwells. Combining observations in the two areas, a complete succession of the Downtonian is obtained, showing a thickness of 2,000 to 2,100 feet. The writer is indebted to Mr. King not only for his guidance in the field over these and neighbouring areas, but also for permission to publish the following brief resumé of the succession. The writer is concerned mainly with the *basal* beds of the Downtonian, and has no wish to forestall the publication of Mr. King's results. Accordingly, only the more salient features are noted here in this tabular summary :—

Dittonian . .	Red or mottled marls with sandstones and cornstones. *Cephalaspis* Sandstone.—A massive sandstone with *Cephalaspis lyelli* and *Pteraspis rostrata*.
Downtonian .	Beds of doubtful age, which have yielded only *Macropetalichthys*. Downtonian or Birch Hill Limestone, with *Thelodus* and other Downtonian fish-remains ; 1,800 feet above the Ludlow Bone-bed. Red and mottled shales and sandstones. Trimpley Fish Zone, with many new species of fishes; 1,400 feet above the Ludlow Bone-bed. Red and mottled shales and sandstones. Holdgate Sandstone.—Massive sandstone with *Onchus*, etc. Horizon of the Ledbury or *Auchenaspis* Fish Zone. Red or mottled shales. Temeside Shales (33 ft. 6 in.). Downton Sandstone (79 ft. 6 in.) with Ludlow Bone-bed at the base.
Upper Ludlovian	Much attenuated at Saltwells.

The *Dayia*, *Rhynchonella*, and *Chonetes* Beds have a combined thickness of only 23 feet 6 inches at Saltwells. It is to be noted that the Ludlow Bone-bed at Saltwells is a calcareous, conglomeratic bone-bed, closely resembling that at Rushall (Woolhope Inlier). Its character and the attenuation of the underlying Ludlovian points to the existence of a region of uplift in late Silurian times to the east or north-east.

These higher Downtonian beds can be traced right through Shropshire, and are also to be found in the Golden Valley and Black Mountain districts of Herefordshire and the Borderland.

[1] King, "The Plexography of South Staffordshire": *Trans. Inst. Min. Eng.*, vol. lxi, 1921, p. 151.

[2] King, *Abs. Proc. Geol. Soc.*, No. 1075, 19th November, 1921, pp. 6–7.

4. *Shropshire—Corve Dale and the Ludlow District.*

The detailed succession in the lower part of the Downtonian in the Ludlow district is well known from the researches of Miss Elles and Miss Slater.[1] A similar succession was shown by them to exist also at Norton, near Craven Arms. Indeed, the lower Downtonian rocks right up Corvedale (to within a few miles of Trimpley) are closely comparable. The sequence in the Linley Brook was described many years by Roberts & Randall.[2] It would appear that the bed there called the "Lower or Ludlow Bone-bed" is in reality the Downton Bone-bed of Elles & Slater, and that the true Ludlow Bone-bed occurs a few feet lower in the "hard calcareous shales with fish-remains". The base of the Downtonian at Skipton (a few yards north of the main road) was examined recently by the writer. Resting on typical Upper *Chonetes* Beds, traces of the Ludlow Bone-bed were found, succeeded by a few feet of soft shales, and then by the Downton Sandstone. In the Ludlow district and throughout Corvedale the red sandstones and marls which succeed the Temeside Shales were considered as Old Red Sandstone by Elles & Slater. In reality the lower 1,500 feet of them are Downtonian (Red Downtonian). Mr. W. Wickham King has been able to trace the fish-bearing horizon of Trimpley right down Corvedale, as well as other beds which he has distinguished in the higher Downtonian. From the abundance and beauty of the fish-remains—many of them new to Britain—which he has discovered, there can be little doubt that this is destined to become classic ground. The fossils recorded from the Ludlow district by Elles & Slater, and those from Norton and Ludlow collected by the writer include :—

Ludlow Bone-bed : 1, 2, 7, 8, 12 ?, 14 ?, 17, 23, 26, 27, 28, 30, 31, 32 ?, 33, 34, 36, 37, 40, 41, 43, 44, 46, 51, 54, 58, 60.

Downton Sandstone : 7, 8, 12 ?, 16, 18, 20, 26, 27*a*, 28, 28*a*, 29, 33, 34, 44, 60.

Temeside Shales : 7, 8, 12, 25, 26, 27, 27*a*, 28, 28*a*, 29, 30, 31, 44, 45, 60, and others, especially fish and eurypthids.

5. *The Malvern Hills and Ledbury.*

For general outlines see Geological Survey maps, 1 inch, Old Series, Sheets 43 N.E. (1845, revised 1855), and 55 S.E. (1853, revised 1855). A normal junction between the Silurian and Devonian occurs nearly the whole way down the western side of the Malvern Hills inlier. An excellent general account is given by Phillips,[3] who states that the Upper Ludlow "flaggy arenaceous shale, with (locally) thin irregular masses of shelley limestone" has a thickness of 100–200 feet, and is succeeded by the Downtonian

[1] Elles & Slater, op. cit.

[2] Roberts & Randall, "On the Upper Silurian passage-beds at Linley, Salop" : *Q.J.G.S.*, vol. xix, 1863, pp. 229–32.

[3] Phillips, "The Malvern Hills compared with the Palæozoic Districts of Abberley, etc." : *Mem. Geol. Surv.*, vol. ii, pt. i, 1848, pp. 94–100.

Sandstone " brown, yellowish, grey, or white laminated sandstone " (thickness 10–100 feet). Detailed sections of the " Passage Beds " at Brockhill and Halesend are given and the presence in the latter locally of some rare minute fish-bones is recorded, indeed, it is even suggested that they may be the equivalent of the Bone-bed of Ludlow. The persistence of organic remains of Silurian types in the lower part of the Downton Sandstone is also noted.

The junction at Halesend is now obscured but the section at Brockhill is still visible. There is an old quarry to the east of the road, south of a small brook, 1 mile north of Colwall Station. The beds dip west at 40–45°. The simplified section is as follows :—

	ft.	in.
Yellowish sandstones with bands of purplish marl . seen for	16	0
Sandstones, fissile, or massive, with bands of grey sandy shale, often micaceous or full or plant-remains	8	4
Hidden by talus, probably same as last	15	0
Very sandy shales, slightly micaceous, some with plant-remains, at bottom a 2 in. band of soft grey clay (? Walker's Earth), with plant-remains	3	0
Ludlow Bone-bed, consisting largely of rolled phosphatic nodules up to ½ in. diameter, *Lingula cornea*, spines of *Onchus*, *Thelodus*, etc., *Chonetes* and fragments of *Discina* are common. There are also ferruginous concretions (? weathered limestone pebbles) full of fossils of *Chonetes* Beds. Rests in hollows of underlying beds.	¼–1	
Chonetes Beds with the usual fossils. Upper part well bedded .	50	0

It should be noted that the Ludlow Bone-bed is really a conglomeratic bed. Very few fossils occur in the Downtonian, despite their abundance in the highest Ludlovian. These features point to a greater break than in the Shropshire areas. Claystone pebbles at various levels indicate contemporaneous denudation.

LEDBURY. In the famous Ledbury Tunnel section the Ludlow Bone-bed was not found. Upper Ludlovian Beds and Downton Sandstone were seen in the tunnel,[1] whilst the whole of the beds exposed in the cutting between the tunnel and Ledbury Station belong to the Downtonian. The succession is :—

	ft.	in.
Red and grey sandstones and clays. Correspond to the Holdgate Sandstone of Trimpley and Corvedale. The " Old Red Sandstone " of Piper. The highest occurrence of *Lingula cornea*	347	0
Purplish grits full of fish-remains. The Ledbury Fish-band or *Auchenaspis* Band	6	0
Purplish grits, red marls with occasional bands of bluish or greenish marl. Some beds yield abundant fish-remains and *Lingula cornea*. With the band above, constitute the Ledbury Passage Beds of Piper[2]	390	0
Downton Sandstone (in the tunnel) . . . stated to be	58	0

[1] Piper, " The Passage Beds at Ledbury " : *Trans. Woolhope Nat. F.C.*, 1895–7, pp. 310–3.

[2] These are not entirely synchronous with the Temeside Shales as suggested by the writer in his former paper, but include representatives of higher beds.

Some distance west of the station, Mr. King has succeeded in finding the Trimpley Fish-zone, and the Dittonian Beds with *Cephalaspis lyelli* are exposed still further west at the famous locality of Bush Pitch.

6. *The Woolhope Inlier, with the Inliers of Hagley, Shucknall Hill, and May Hill.*

These districts are shown on the Old Series Geological Survey's maps, Sheets 43 N.W., 1845, and 43 N.E., 1845, revised 1855.

(*a*) *Hagley.*

This Silurian Inlier, which appears to have an area of not more than an acre, was first described by Strickland[1] in 1852, but is not indicated on the Survey's maps. It is situated to the south of the main road near Lugwardine, 3 miles E.N.E. of Hereford. The section is taken from the centre of the western face of the old quarry about 150 yards west of Hagley Hall :—

	ft.	in.
Bedded green marls, weathering red, with lenticular band of greenish, irregularly bedded sandstone	7	6
Massive greenish sandstone	2	4
Soft, greenish-grey, thinly laminated micaceous shale full of plant-remains	1	0
Greenish-yellow, false-bedded sandstone, with fossils	4	0
Soft, greenish-grey shales, as above		4
Greenish-yellow sandstone, as above	4	3
Ludlow Bone-bed (only seen by removing fallen debris)		1
Upper Ludlovian grey micaceous shale, full of fossils . more than	4	0

Strickland gives an extensive list of fossils from the Upper Ludlovian (including 33, 34, 39), and from the Bone-bed records 1, 7, 39, 40. He states that the Bone-bed varies from "a wafer" to 1½ inches in thickness, and also that plates of *Thelodus* are occasionally found in the shales immediately below. The "Green Marls" of the above section were placed in the Old Red Sandstone by him. From the Downton Sandstones (above the Bone-bed) the writer obtained 1, 2 ?, 7, 8, 18 (fragments), 26, 33, 37, 44 (rather large), 59 ?, 60, 61.

(*b*) *Woolhope Inlier.*

The greater part of the junction between the Silurian and the Devonian round the Woolhope Inlier has been mapped on the 6-inch scale. Below are detailed a number of typical sections, starting from the western side, working round the northern and eastern to the south of the inlier.

(i) Fownhope (Herefordshire, XL, SE.). In an old quarry 300 yards north of Mill Farm, just inside the wood, the following section was seen (1919), the beds dipping west at about 30° :—

[1] Strickland, "On a protruded mass of Upper Ludlow Rock at Hagley Park in Herefordshire" : *Q.J.G.S.*, vol. viii, 1852, pp. 381–5.

	ft.	in.
Disturbed mass of purplish shales, etc., above.		
Yellowish or greenish sandstone with bands of soft shale. A bed full of black carbonaceous markings and *Pachytheca* at the base	8	0
Greenish-yellow sandstone, thinly bedded (tilestone) in places. The lower part is full of flattened "pebbles" of shale, forming a Claystone Conglomerate. Sharp junction with the underlying beds	2	6
Chonetes Bed.—Irregularly bedded calcareous flags with abundant fossils (*Chonetes striatella*, *Orthis lunata*, *Orthoceras*, etc.). Seen for	8	0

(ii) Cockshoot and Prior's Frome (Here. XL. N.E., and XXXIV. S.E.). Just north of Orchard Farm there is a long cliff of Ludlovian rocks. At the southern end, owing to the dip, Downtonian rocks appear, and the following section is exposed :—

	ft.	in.
Massive purplish-brown sandstone, some layers with plant-remains; false bedded but non-fissile. There are irregular claystone conglomerates at intervals, containing obscure fish-remains, *Pachytheca* and fragments of *Discina* . seen for	6	0
Micaceous sandy shales, false bedded, with some plant-remains	1	0
Very thin conglomerate (pebbles of underlying *Chonetes* Beds) occupying hollows in bed below		
Chonetes Beds.—Calcareous flags . . . . seen for	50	0

Opposite the Yew Tree Inn at Prior's Frome there is a good exposure, the beds dipping westwards at about 30° :—

	ft.	in.
Soft shales and sandstones, with occasional fish-remains seen for	3	0
Conspicuous band of very hard conglomeratic quartzite (pebbles of shale and phosphatized material) with fish-remains (*Onchus*) in the lower part		8
Soft false-bedded shale, full of plant-remains. There are irregular bands and patches of conglomerate (with pebbles of Upper Ludlow rocks up to 1½ inches long)	5	0
Band of micaceous blackened sandstone with small pebbles, obscure fish-remains (*Thelodus* is abundant and varied), and casts of Chonetes		
Chonetes Beds.—Irregularly bedded flagstone . . seen for	50	0

The great difference between the last two sections (especially in the lower beds of the Downton Sandstone), although they are less than half-a-mile apart, is remarkable. A section in the lane between the two localities has been described by Phillips.[1]

[1] Phillips, op. cit., p. 175.

(To be continued.)

REVIEWS.

Die Gebirgsbildung der Erde. By C. Mordziol. pp. 30. List and von Bressendorf, Leipzig, 1922.

Die Schrumpfung der Erde. By H. Stille. pp. 37. Gebrüder Borntraeger, Berlin, 1922.

BESIDES the well-known publications of Wegener, which have recently attracted so much attention in this country, there has been of late in Germany a considerable output of literature dealing with the tectonics of the earth's crust. The first of the pamphlets named above begins with a criticism of the methods of investigation hitherto pursued, laying special stress on the prevalence of preconceived ideas in the explanation of the phenomena observed in mountain structure, which the author considers has led to many errors. He then proceeds to put forward his own theory, which attributes mountain-building largely to tangential thrusts produced by liquation and magmatic differentiation. This is in accordance with some views recently enunciated by Penck on the basis of his observations in the Cordillera of South America. Great stress is laid on what is called the plutonic relief of the earth; that is to say, the form of the igneous material after removal of the superficial and secondary deposits, including all sediments and apparently all effusive volcanic rocks. Mordziol's hypothesis is summarized by himself as follows: the general equilibrium of the masses composing the earth's crust is explicable by the phenomena of magmatic differentiation, especially by differential compensation. Both the earth and the moon possess subcrustal differentiation-foci; these control the relief of the surface from the morphological point of view, and also dominate the tectonics of the crust dynamically.

The second publication is a reprint of a special lecture given at the annual festival of the University of Göttingen, in July, 1922. It also comprises some valuable notes and bibliographical matter. The main thesis is that the idea of contraction as a dominant factor in tectonics is by no means such a back number as many writers would have us believe. Much importance is attached to the distribution of gravity-anomalies, and it is also pointed out that too little attention has been paid to the time-factor in tectonics, to the rhythmic succession of periods of rest and disturbance, and to the contemporaneity of folding in widely separated areas. Most of the prevailing theories of isostasy and mountain-building also fail to take account of the great and important class of epeirogenetic movements, the secular risings and sinkings of vast areas of the crust. A very full consideration is given to the consequences of the theory of contraction in the light of the results of modern physics and chemistry. An important point made here, and one often neglected by the opponents of the theory, is that contraction does not only depend on the temperature-coefficient of rock-material, but that, so far as we know, all such material solidifies (crystallizes) with a decrease of volume, often amounting to as much as from 6 to 9 per cent. The author concludes that not only is the

nebular hypothesis of Kant and Laplace by no means superseded, but, on the contrary, it is susceptible of much further amplification.

From these recent publications it would appear that the newer developments of cosmogony, especially the doctrine of isostasy, do not receive much support from the trend of current German opinion, while the planetesimal theory of the origin of the universe is not even mentioned. These are great matters, in a sense outside the true field of geology, nevertheless geologists are bound to take them into account, since their effects are not confined to the earlier cosmical phases of earth-history, but make themselves felt throughout the geological record, even up to the present time. However, it may be said that the solution of these problems is now more and more passing out of the hands of geologists and into the province of geodesy, physics, chemistry, and mathematics. An enormous amount of material has now been accumulated by observation and experiment, as well as by theoretical researches, and now awaits co-ordination by a master mind into a new Theory of the Universe, to revive a phrase from the earlier days of our Science, a phrase which was born out of due time, and therefore much discredited, but which is likely in the future again to become prominent in scientific literature.

THE GEOLOGY OF THE COUNTRY AROUND COVENTRY, INCLUDING AN ACCOUNT OF THE CARBONIFEROUS ROCKS OF THE WARWICKSHIRE COALFIELD. By T. Eastwood, W. Gibson, T. C. Cantrill, and W. H. WHITEHEAD, with contributions by H. H. Thomas and the late C. H. Cunnington. *Mem. Geol. Surv.*, explanation of sheet 169, 1923. Price 5*s*.

THE appearance of this memoir will be welcomed by all students of Midland Geology, and more particularly by mining and civil engineers connected with the Warwickshire and adjacent coalfields. It gives an authoritative account of a coalfield, long worked in its exposed northern part, but now rapidly developing in its buried southern extension around Coventry.

In the detailed description of the Productive or Middle Coal Measures, an account is given of the coalescing of at least five seams to form the " Thick " Coal, of the variations in quality and thickness of the various seams in the different parts of the field and of the extensive wash-outs to which the coals are liable, while the tectonics are carefully discussed. The chapters devoted to the above are excellent and illustrated more fully than is usual in Geological Survey Memoirs by means of plates of sections.

In view of the problems to be found in the future development of the coalfield, the most important part of the memoir is that devoted to the overlying barren Upper Coal Measures, which are classified as follows :—

	Feet.
Corley (Enville) group . . .	1,700
Keele group	900
Halesowen Sandstone group . .	400
Etruria Marl group . . .	150

In dealing with these, emphasis is laid upon features by which recognizable horizons may be determined. In this connexion, the value of the Spirorbis limestones is stressed. The data are discussed that have led to the proof of the complete conformity of the above series to one another and collectively to the underlying Productive Measures. It follows from this not only that the Corley group must logically be regarded as Carboniferous rather than Permian, but also that the structure of the buried coalfield can be deduced from that observable in the upper series at their outcrop. Using the data obtained during the re-survey, the authors have produced an instructive map contoured to show the depth of the Seven-foot Coal throughout the field. Important conclusions are drawn from this as to the possible extensions of coal mining under the barren upper measures, while on another page the chances of finding coal below the Trias beyond the boundary faults of the coalfield are discussed.

One curious feature of the map, of which this memoir is explanatory, deserves adverse criticism, viz. on the northern edge, where the Etruria Marls and Halesowen Sandstones enter the map, they are coloured as Productive measures (with the exception of the sandstone and limestone bands) as far south as the Arley fault in order to comply with the colouring in the adjacent sheet 155, published as long ago as 1899. No mention of this is made on the map or in the memoir. Surely improvements due to our increased knowledge should have been incorporated and the map and its legend made to agree throughout.

Returning to the memoir, the Pre-Cambrian rocks are described in adequate detail; but the Cambrian rocks and the Glacial Drifts are not so skilfully dealt with. The really interesting scientific aspect of the former is obscured by a cumbersome mass of details about quarries, drilling-machines and latitudes and longitudes. Some of this might well have been replaced by a fuller description of the faunal sequence in this classical area. Every geologist will feel the want of this in a memoir descriptive of the Stockingford and Nuneaton Cambrian.

The Glacial deposits cover half of the area described and embrace a varied assortment of Eastern and Western Drifts. Thus the Glaciology deserves a more comprehensive treatment than that meted out to it in the three and a half pages devoted to its general description.

L. J. W.

THE CHROMITE OF KENAI PENINSULA, ALASKA. By A. C. GILL. Bull. 742, U.S.G.S. pp. 52, with 4 plates. Washington, 1922.

SOME chromite has been produced on a commercial scale from deposits near the south-western extremity of the Kenai Peninsula, at about 60 degrees N. and 150 degrees W. The chromite is restricted to two areas of dunite, more or less

serpentinized and surrounded by metamorphosed Palæozoic or early Triassic sediments. Owing to the peculiar field-relations, a suggestion has been put forward that the dunites were not intruded in magmatic form, but may have been thrust into or through the sediments when already solid. The author is, however, very sceptical as to this. The chromite occurs as very distinct bands in the dunite, mixed with more or less olivine. There is every indication that the banding is due to flow of a heterogeneous magma. The chromite contains also a good deal of magnesia and alumina, and must be regarded as a mixture of various spinel molecules.

CIVIL ENGINEERING GEOLOGY. By CYRIL S. FOX, B.Sc., M.I.M.E. pp. 144 with 14 plates and 66 figures. (Crosby Lockwood and Sons, Ltd. Price 18*s.* net).

THIS interesting volume is based largely on the author's wide experience in India, both on the Geological Survey and as consultant for various geological features met with by the civil engineer in selecting suitable sites for reservoir dams and other engineering works.

The book is divided into three parts, viz. Water Supply and Irrigation, Field Operations, and Building Materials, with suitable chapters appropriate to each section.

The author has presented the geological features in such form as should appeal to the civil engineer and student.

The chapter dealing with reservoir dams, retaining walls, and tunnels describes in detail the deciding factors to be considered by the engineer in locating the sites for these works.

The book is well illustrated with photographs and figures and is one that should be included in the library of every engineer.

L. E. WILSON.

CATALOGUE OF METEORITES. By G. T. PRIOR, pp. ix + 196. Printed by order of the Trustees of the British Museum, London, 1923.

THE present catalogue, so far as it relates to specimens in the British Museum, is intended to replace the list of meteorites which appeared in the "Introduction to the Study of Meteorites" by the late Sir L. Fletcher. It includes also brief accounts, with synonyms and classification, of all known falls. In glancing through the list one cannot help wondering why so many of them elected to come down at places with specially outlandish names; and in speaking of names it is pleasing to note that the author has made a stand against the Germanization of Russian words by substitution of *w* for *v*, a practice which has been followed far too long in this and other countries, since the Russian alphabet possesses a perfectly good and unmistakable *v*, pronounced as such. In one or two instances, however, a Teutonic *tsch* (for *ch* or *tch*) has escaped his

eagle eye. A particularly useful feature of the catalogue is the information given in each case as to the whereabouts of specimens. The brief introduction gives a synopsis of the classification adopted, that of Tschermak and Brezina as modified by the author in 1920. All well-authenticated falls not represented in the British Museum Collection are marked with an asterisk : the proportion is astonishingly small. This book is a mine of information for all interested in the subject.

SOUTHERN RHODESIA GEOLOGICAL SURVEY.

Short Report, No. 13. "GEOLOGICAL RECONNAISSANCE IN THE SANYATI VALLEY," by the late A. J. C. MOLYNEUX. pp. 10 and map with some geological data.

THIS Report, dealing with the Sebungwe and Lomagundi Districts, over 200 miles N. by E. of Bulawayo, is a record of various traverses made in 1910 and 1912 by Mr. Molyneux. In a preface of a dozen lines, the Director has summarized this Report, emphasizing the presence of a small outlier of basalt, presumably of Karroo age, on the Lomagundi plateau, and of a boulder-bed " which bears a strong resemblance to a tillite " in the Lomagundi sediments. The part of that great system exposed appears to belong to the uppermost and thickest division, the Piriwiri Series, and it becomes a matter of interest to learn whether the glacial bed (if the identification is confirmed) found by Mr. Molyneux can be correlated with that of the Lower Griqua Town Beds of Northern Cape Colony and with the glacial conglomerate described by Grosse from the base of the Katete Beds near Lake Mweru, localities widely apart. " Granite and Gneiss," a term comprising a number of rocks of different ages and origins, occupies a large part of the ground covered. The sketch-map of the Sanyati Valley attached to the Report covers an area of about 5,500 square miles.

Short Report, No. 14. "PRELIMINARY REPORT ON THE GEOLOGY OF THE COUNTRY AROUND THE LONELY MINE." By A. M. MACGREGOR, 1923, pp. 10 and Geological Sketch-map.

THE interest of this Report, dealing with typical Matabeleland schist country, lies in the fact that it is largely concerned with the oldest rocks yet known in Rhodesia—the Basement Schist Series. This is divided into two, of which the upper, the Ndutjana Series of grits, conglomerates, etc., separated from the lower by an unconformity, can be dismissed as being in a somewhat different category to that of the underlying essentially volcanic series ; perhaps rather, as in Canada the Temiskamian differs from the Keewatin. The lower group, the Greenstone Schist Series, is divided in the text into six sub-groups, but in the Geological Sketch-map, which covers an area of some 750 square miles, with the Lonely Mine (46 miles N. by E. of Bulawayo) in its centre, into three. These are banded ironstones, basic greenstones (chiefly pillow-lavas), and acid and

intermediate volcanic schists. The more detailed sub-division shows that pillow-lavas occur on two horizons. In that of the Lonely Mine is interbedded one horizon of banded ironstones; another of the same rock type is included in the Bubi Source Schists, the lowest sub-group; the Zwankendaba Ironstone Group, the gold-bearing formation of many mines to the south, forms a third.

This is a "Short Report", and we must hope that later more detail will be forthcoming on the structure of these volcanic rocks, and, if funds permit, a few illustrations, which would be an immense help to better comprehension and invaluable for comparison with other areas. No thicknesses are given, but one recalls the Director's estimate of over 30,000 feet for the Basement Series: truly a mighty accumulation. These rocks occupy by far the greater part of the area shown on the map, they are flanked to east and west by intrusions of granite (frequently markedly gneissose) and overlain by beds of the upper Karroo System and inconsiderable deposits of Kalahari Sands.

Short notes are given on the Economic Geology.

PETROLOGY FOR STUDENTS. By ALFRED HARKER. Sixth edition, pp. 302, with 100 figures. Cambridge University Press, 1923. Price 8*s*. 6*d*. net.

IT argues well for the continued interest in petrology that a new edition of Mr. Harker's well-known book should be required only four years after the appearance of the last. In this, the sixth edition, the changes are small. The progress of the science in this country has enabled the author to continue his wise policy of substituting wherever possible British examples for the foreign rocks described as types in the earlier issues, thus increasing the usefulness of the work. Several new figures have been added and some old ones withdrawn. It is pleasing to note that the reproduction of the figures is considerably improved, and they now do justice much more fully to the author's instructive and beautiful drawings.

PETROGRAPHIC METHODS AND CALCULATIONS. By A. HOLMES. In three parts. Part I: Specific Gravity, Separation and Determination of Minerals, Detrital Sediments, 15*s*. 6*d*. net. Part II: The Study of Thin Sections, 10*s*. 6*d*. net. Part III: Chemical Methods and Calculations, 8*s*. 6*d*. net; or in one volume, 31*s*. 6*d*. net. London, Murby, 1921.

HITHERTO the chief obstacle to the widespread utilization of Dr. Holmes' useful book has been its high price. The scope of the work is very wide, and as it appeals mainly to those engaged in research the more specialized workers have hesitated before paying a guinea and a half for a book of which a large part does not particularly appeal to them. The publishers have now sought to

remedy this by issuing the work in three separate parts, as above specified. We trust that this will lead to a still wider appreciation of this book, which is extraordinarily useful, containing as it does a vast amount of information collected from widely scattered sources, many of which are to all intents and purposes inaccessible to those not having access to a first-class library. This remark applies with special force to the sections dealing with sediments and chemical methods. Of treatises on rock-slices there are legions, but sedimentary petrography is a much neglected field of far greater practical importance, and at the same time more difficult than the study of igneous rocks. There are signs, however, at the present time that this subject will soon attain its rightful place as one of the main branches of geology.

The Igneous Complex of Leeuwfontein, Pretoria District. By S. J. Shand, D.Sc. Trans. Geol. Soc. S. Africa, XXIV, 1921, pp. 232, 1 plate, 1 map.

In the foreword the author deplores the fact that in the case of the alkaline rocks of South Africa petrography has been allowed to outrun geology, and the present paper is the outcome of an investigation of one of the series with a view to ascertaining more about the mutual relations and structural details of the rock masses.

He commences with a series of observations of the rocks viewed from this standpoint, a noteworthy point about the descriptions being the simplified nomenclature of types, an example being the use of *syenite* (*Aker type*) for that dreadful word *Leeuwfonteinite*.

With regard to the structural petrology, the author considers that this well-known series occupies an actual volcanic neck from which some of the Waterberg felsites were extruded. The successive confocal arrangement of the Aker, Umptek, and Foya type syenites he attributes to successive freezing and paroxysmal reopenings of activity in the plug. The general chemical trend shows a decrease in SiO_2, CaO, MgO, and an increase of alkalies and Al_2O_3 in the later types. There is no direct evidence that this progressive desilicification of the differentiates was due to interaction with the Dolomite formation of the Transvaal.

This paper is the first of a series dealing with the four alkaline syenite plugs of the Transvaal.

J. E. A. W.

Imperial Institute Monographs on Mineral Resources. Copper Ores. By R. Allen, pp. x + 221, with a map, 7*s.* 6*d.* net. Mercury Ores. By E. Halse, pp. 101, with a map. 5*s.* net.

These two volumes follow the general plan of this useful series, the copper monograph being naturally of somewhat larger size than usual, owing to the importance of the subject and the very wide distribution of the ores. As the map shows, there is scarcely

a country in the world that does not yield copper, even many of the more remote and inaccessible areas, such as the Belgian Congo, being large producers. Besides a full description of apparently all known occurrences of importance, the author gives many interesting details as to the copper markets of the world and the financial control of the chief producing districts. It is hardly necessary to insist on the predominant position now held by the United States in this industry, a sharp contrast to the state of affairs not so long ago, when the Parys mine in Anglesey pretty well controlled the world's markets.

On the other hand workable deposits of mercury are very limited in their geographical distribution, and since the acquisition of the territory including the mercury mines of Idria the leading position is now held by Italy. Since the war Austria and Hungary have disappeared from the list of producers and, owing to various economic difficulties and new arrangements, the Spanish output from Almaden has greatly diminished. The geology of the mercury deposits is of special interest since they furnish working models of the genesis of ore-deposits, casting much light on the origin of other ores of more deep-seated character whose formation is not accessible to direct observation.

Memoir and Map of Localities of Minerals of Economic Importance and Metalliferous Mines in Ireland. By Grenville A. J. Cole, F.R.S. Mem. Geol. Survey, Ireland. pp. 155, with 1 plate and folding map in pocket. Dublin, 1922. Price 7*s.* 6*d.* net.

THIS memoir will be of the greatest use to all who are interested in the development of the economic resources of Ireland; it includes both the Free State and Ulster, having doubtless been prepared before the recent political separation. The introduction contains a summary of previous literature and maps relating to the subject, while the chapters are divided according to the different metals and minerals: in each chapter details are given so far as available of all known occurrences, with map numbers. The frontispiece is a photograph of a bust of Sir R. J. Griffith, Bart., the greatest pioneer of Irish geology.

REPORTS AND PROCEEDINGS.

Mineralogical Society.

13*th March.*—Dr. A. Hutchinson, President, in the chair.

Dr. A. Hutchinson: A graphical method of correcting specific gravity determinations. A diagram is given by which the correction for air displacement and reduction to 4 degrees C. can be read off directly.

A. Brammall and H. F. Harwood: The Dartmoor Granite (Widecombe Area). Field evidence and analyses support the con-

clusion that the granite is a composite laccolith, and that four successive stages of intrusion are recorded by (1) dark and relatively basic granites scantily exposed and by certain cognate xenoliths resembling basic segregations; (2) a more acid granite which caps many tors and yields mineral evidence of having assimilated country rock; (3) a still more acid granite intrusion into the latter; (4) minor acid intrusions, felspars, garnet, cordierite, etc., are described, and evidence for differentiation is given.

C. E. Tilley: Genesis of Rhombic Pyroxene in Thermal Metamorphism; Mineral Associations and the Phase Rule. Free-silica-hypersthene-bearing hornfelses of sedimentary origin can be divided into a calcic and non-calcic group, and considered as derived from a normal shale hornfels by increments either of CaO, (MgO+FeO), or less commonly K_2O. Silica-poor hypersthene-hornfelses can be derived from the free-silica types, and the hypersthene is then frequently accompanied by spinel. The derivation of all these hornfelses can be graphically expressed in systems of three or four components. The hypersthene is derived from the chlorite in the original sedimentary rocks subjected to metamorphism. Hypersthene arises when enstatite, augite, or amphibole-bearing igneous rocks enter contact aureoles, and examples of these are given. Reference is made to the production of rhombic pyroxene by contamination of gabbroic rocks. The hornfelses are considered from the standpoint of the phase rule, a classification suggested, and the condition of equilibrium in the inner zone of hornfelses in contact aureoles discussed.

C. S. Garnett: On a Peculiar Chlorite-rock at Ible, Derbyshire. A band in the dolerite sill at Ible is completely altered to a foliated mass of chlorite, with associated veins of fibrous chlorite (resembling chrysotile in appearance). The analyses and characters of this material are compared with those of "epichlorite".

C. S. Garnett: The Dissociation of Dolomite. The statement in the textbooks that dolomite dissociates in two stages, giving when half-burnt a mixture of calcium carbonate and magnesia, is not confirmed. Dissociation is inappreciable up to 625 degrees, and at 898 degrees it is complete. The temperature-dissociation curve is continuous.

J. G. C. Leech: Occurrence of Rutile, Brookite, and Anatase in the St. Austell Granite. These minerals occur in the red pneumatolyzed granites of the area, the mode of occurrence being essentially the same as that recorded for Dartmoor occurrences of these minerals.

GEOLOGISTS' ASSOCIATION.

Friday, 1st June, 1923.

"The Geology of the Country around East Grinstead, Sussex," by Henry B. Milner, M.A., D.I.C., F.G.S.

Physiography—Stratigraphy—The Grinstead Clay and Pebble

Beds: a study of the facies—Petrography of the Sediments—The application of Petrographic Methods to the Correlation and Differentiation of beds in the field—Structure of the area—Folding and Faulting—Tectonic relationship of the area to the Central Weald—Some problems in Wealden Geology.

"The Pleistocene Deposits of the Portsmouth District and their Relation to Man," by L. S. Palmer, M.Sc., Ph.D., and Lt.-Col. J. H. Cooke.

This paper is divided into five sections; the first being a short introductory account of the gravel deposits of the district. Three terraces are distinguished, and various exposures near the coast showed three raised sea-beaches at corresponding levels. The second section deals with the stratigraphy of these terraces. In many respects there are points of resemblance between the terraces, whilst in other details important differences occur, such as an increase in the number of Coombe Rocks with increase of terrace level above O.D. The faunal remains are discussed in the third section and the flint implements in the fourth. Both these sets of evidence indicate that the fluviatile gravels of the uppermost terrace were laid down about the same time as the basal layers of the lowest terrace, and that the climate was not colder than that of the present day. This period was followed by colder periods, during which the later deposits were formed. Unabraded Acheulean implements were found in the lowest deposits, whilst Mousterian and Aurignacian artefacts occurred in the upper layers. In the last section an attempt is made to correlate the data of the preceding sections.

An appendix by Mr. A. S. Kennard gives a list of the molluscan remains found in the Upper Coombe Rocks of the Middle Terrace.

CORRESPONDENCE.

Sir,—In my paper on "Glaciation", published in your January number under the date 1897, reference is made to conglomerates at Silverwood and Cherry Gully Railway Stations.

Through a communication received from Professor Richards, of Brisbane, I find that I was mistaken in classing them as Glacial conglomerates and of the same age as the Ashford N.S. Wales Glacial conglomerate.

E. J. Dunn.

TOR *v.* INSELBERG.

Sir,—In his letter in the April number, Professor Gregory renews his attack upon the term "inselberg", but I can think of various objections to his contention. Why, for instance, should one use the provincial term "tor" in place of the international term "inselberg"? Surely the more international terms one can introduce into geological literature the better. Further, the term "tor" does not convey to me the same ideas of magnitude and place

relations as the term "inselberg". Is the converse of Professor Gregory's proposition true, for example? Would Professor Gregory in describing the scenery of Dartmoor to a German-speaking scientist speak of the tors as inselberge? An "inselberg" is typically an island mount or mountain, usually under 1,000 ft. in relative elevation, rising abruptly from an extensive plain like a rocky island from the waters of the ocean. The imagination is stimulated by the term "inselberg", but not by the term "tor". It is somewhat far-fetched of Professor Gregory to say that an "inselberg", to deserve its name, should rise out of water or out of alluvium. Even in English, the word "island" is often used as a figurative prefix. We speak of an "island-platform" and of an "island-refuge", though neither of these as a rule rises out of water or out of alluvium. Further, Professor Gregory would appear to be in favour of an author using a term to denote a surface feature which would imply his particular theory of the origin of the feature. This principle, however, is not to be commended, as it would lead to the multiplication of names for any feature of disputed origin. Non-committal terms should be used in all such cases, and it is the great advantage of the term "inselberg" that it is purely descriptive and entirely non-committal in respect of the origin of the feature so described. Thus the term "tor" as a substitute for "inselberg" is completely ruled out, because Professor Gregory has defined tors as "residual hills, left by the denudation of mountain ranges", and again as "fragments of old mountains destroyed by denudation" (Rift Valleys and Geology of East Africa, p. 36). Apart from the difficulty of believing that the tors of East Africa are the actual remnants of Eozoic mountains, this is certainly not the origin of many of the inselberge of Nigeria, which may be seen in places in process of emergence from the plains under present conditions of erosion. Others again are relics of formerly more extensive isolated masses of rock which have been subdivided and dissected by such processes as those described by Mr. Bain. No single theory, however, is likely to suit all cases, and for this reason the term "inselberg" is in my opinion much too useful to be lightly discarded from geological literature.

J. D. Falconer.

Nigeria.
2nd May, 1923.

[This letter is printed exactly as received, as were Mr. Bain's paper and Professor Gregory's letter. The Editor would, however, be glad of an authoritative ruling as to whether the German word "Inselberg" is now sufficiently naturalized in English to be written with a small initial letter. The Editor is of opinion that if this is the case the plural should be "inselbergs", since "inselberge" is neither German nor English. A great deal of editorial time would be saved if authors, reviewers and correspondents would kindly remember that all German substantives begin with a capital letter,